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DESCRIPTIVE AND ILLUSTRATED CATALOGUE

OF

THE PHYSIOLOGICAL SERIES

OF

COMPARATIVE ANATOMY

CONTAINED IN

THE MUSEUM

OF

THE ROYAL COLLEGE OF SURGEONS IN LONDON.

VOL. III.—PART I.

NERVOUS SYSTEM AND ORGANS OF SENSE.

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PREFACE.

As the Third Volume of the Physiological Catalogue is designed to include the remaining Series of the first Division of the Preparations of Comparative Anatomy, the Board of Curators have directed its publication in Two Parts, of which the First is descriptive of the Nervous System and Organs of Sense; the Second will relate to the Connecting and Tegumentary Systems, and the Series called Peculiarities.

The Hunterian manuscript Catalogue has supplied, as in the preceding volumes, the Introductory Exposition of the general nature and arrangement of the different Series; but the original descriptions of the individual specimens are very few, and more than usually brief and imperfect.

The dissections of recent animals required for the identification of the unnamed specimens, and, in many instances, no less requisite for their detailed description, have protracted the completion of the present Part beyond the period originally anticipated, and will continue to be a source of unavoidable delay; especially since the detected inaccuracies of the manuscript Catalogue have rendered it imperative to verify its descriptions by a comparison of the Hunterian specimen with the same organ in the animal to which it is stated to belong; which has been done in each case before adopting the description or denomination in the present Catalogue.

The descriptions which, after such verification, have been adopted from the original Catalogue are printed, as in the preceding volumes, between inverted commas. The Hunterian descriptions of the Plates taken from the manuscript Catalogue of Drawings, and the observations descriptive or explanatory of several preparations derived from the published works of Mr. Hunter and from other sources, are similarly indicated and quoted.

The Founder of the Collection, in his description of the Organ of Hearing in Fishes, observes that " he is inclined to consider whatever is uncommon in the structure of this organ as only a link in the chain of varieties displayed in its formation in different animals, descending from the most perfect to the most imperfect in a regular progression."

The same philosophical perception of the unity of plan to which the various modifications of each organ are referrible, is manifested throughout the Collection of Comparative Anatomy, and more especially in those Series which are described in the present volume: and whether we consider the number and variety of animals from which these specimens have been taken, or the skill displayed in their preparation, or the masterly and comprehensive views which have governed their selection and arrangement, we cannot fail to acquire a renewed conviction of Mr. Hunter's preeminence as a Physiologist and Comparative Anatomist.

In the Preface to the First Volume of the Physiological Catalogue Mr. Hunter's character as a Systematic Naturalist is alluded to; and, as a sketch of a primary division of Animals is contained in one of the explanatory Introductions published in the present Fasciculus, we have deemed this a suitable opportunity for bringing into one view and commenting upon his various endeavours to form a Distribution of the Animal Kingdom according to its organization.

In the Introduction to the preparations of the Stomach, Mr. Hunter observes, that " animals in general might be tolerably well classed by the 'organs of digestion*'." When treating of the Circulating System† he goes further, and gives an outline of the arrangement of the animal kingdom founded on the differences in the structure of the heart, and proposes denominations for the classes expressive of such differences. This, which may be termed the 'Cardiac Arrangement', appears to have been the favourite one with Mr. Hunter, from the frequent reference to it in the 'Treatise on the Blood and Inflammation'; and so far as it is applied to the Vertebrate classes it is in close accordance with the Natural System. The following outline of it is contained in the copy of a Hunterian manuscript in the possession of Mr. Clift.

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* Gallery Catalogue, i. p. 113.

† Ibid., ii. p. 146.

"*Different Classes of Animals according to their Hearts.*

"1. '*Tetracoilia*', those that have four cavities.

"2. '*Tricoilia*', those that have three cavities, which includes both land, sea, and amphibious animals*.

"3. *Dicoilia,* those that have only two cavities, as Gill-fish.

"4. *Monocoilia,* those that have but one cavity, such as all kinds of Insects.

"5. *Acardia,* those whose stomach and heart are the same body, as in the Blubber, Polypus, &c."

This manuscript is accompanied by a sketch of an arrangement of animals according to their "Organs of Respiration".

"The 'first class' includes all those animals which have lungs, with cells through the whole, and a diaphragm.

"The 'second', all those which have their lungs attached to the ribs, so as to confine them to their place.

"The 'third', all those whose lungs come into the belly and are loose.

"The 'fourth', all those whose lungs are in their necks, called gills.

"The 'fifth' are reptiles, whose lungs are in their sides†."

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* As, for example, the Land Tortoise, the Turtle, the Frog, &c.

† By Reptiles Mr. Hunter signifies 'creeping things', or Invertebrata in general; and consequently his fifth class would include most of those which possess respiratory organs, as Insects, Crustaceans, Mollusks, and most Anellidans.

In the copy of another Hunterian manuscript, there is the following scheme, entitled

“ *Classes of Animals according to their parts of Generation.*

“ 1. *Vivipara,* those that bring forth from the uterus, from a mixture of male and female influence; such as all the ‘first class’ according to Organs of Respiration, both sea and land.

“ 2. ‘ *Ovovivipara*’, or ‘ *Vivum ex ovo*’, those that may be said to hatch their young from an egg in the oviduct, as most Vipers, Slow-worms, some Lizards, Newts: this is confined to part of the ‘second class’ according to Hearts, and to some of the ‘third’, as the Dog-fish.

“ 3. *Ovipara,* those that throw their eggs out and are hatched out of the body. This takes in a large field, viz. part of the ‘first and second classes’ (according to Hearts), the greatest part of the ‘third’, and perhaps all the ‘fourth’.

“ 4. We have animals that propagate their species by slips, and that in two different ways, one by a piece cut off, the other a natural process, viz. branches growing, and these falling off and producing a distinct animal, which can only take place in animals, as only that being has the power of separation, and the power of afterwards catching its food, which admits of a continuation of life.”

Mr. Hunter seems conscious, however, of the unsatisfactory ground afforded by the Generative system for classification; for he observes that “ animals of any particular class have not one way only of propagating their species, excepting the more perfect or first class of animals according to Hearts; for we have the second and even the third class aping the first, and attempting to be viviparous, as Vipers, Lizards, and some Fishes, as the Skate.”

This idea of an arrangement of animals according to the modifications of the Generative system has been carried out by Sir Everard

Home, and applied to the formation of the subordinate groups. See the 3rd volume of his *Lectures on Comparative Anatomy.*

In the present volume of the Physiological Catalogue, Mr. Hunter proposes another scheme for the distribution of the animal kingdom, based on modifications of the Nervous system; and this scheme is indicative of the natural affinities of a greater proportion of the animal kingdom than any of the preceding methods, for we find in the class characterized by a brain in the form of a ring*, an indication of the Molluscous division of Cuvier.

All these classifications are, however, subject to the same objection, viz. that the groups are not of equal value; for, as a natural consequence of the different degrees of knowledge which Mr. Hunter possessed of the organization of the vertebrate and invertebrate animals, he constantly makes the '*Classes*' of the former, which are groups of secondary value, equivalent to '*Divisions*' of the latter, which are groups of primary value in the animal kingdom.

The object of every good classification being the power of expressing by general propositions the details of organization common to each group, it follows, that that organ or system of organs which characterizes, by a given modification, the greatest number of animals will indicate the groups of primary importance, and that the value of the other organs as zoological characters will be in proportion to their degrees of subordination to the ruling system of the animal organization.

Now the nervous system may be said to be the essence of an animal, since all the other systems are subservient to and more or less directly influenced by it; and consequently it is found that the divisions of the animal kingdom which are characterized by the different types or plans according to which this system is disposed, are of primary value.

We are informed that Mr. Hunter attributed to the lowest organized animals a condition of the nervous system more simple than any of those which he has described in his introductory observations on the Brain*.

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* See p. 4.

This condition is thus described by Sir Anthony Carlisle in his 'Observations on the Structure and Œconomy of *Tæniæ*†': "I have never seen anything resembling brain or nerves in the *Tæniæ*; but as they are highly sensible to stimuli, it is most reasonable to conclude, that they have a considerable portion of nervous matter in the composition of their bodies; that is, of such matter as is susceptible of stimuli. Indeed, we can hardly conceive how any animal can exist without such matter in its composition." Sir Anthony then adds in a note: "After I had written this essay I learned that Mr. Hunter entertained a similar opinion to that which is now stated, and which he applies to many of the lower tribes of animals." The animals so characterized by a diffused or molecular condition of the nervous system include the lower organized *Infusoria*, the *Spongiæ*, the class *Polypi*, with the more simple *Entozoa*, as the Tape-worms, Hydatids, &c., and the *Acalephæ*.

In this division of the animal kingdom, which has been termed *Cryptoneura*‡ and *Acrita*§, there is no distinct circulating or respiratory organs; and the digestive tube, instead of being contained in a distinct abdominal cavity, is simply excavated in the parenchyma of the body, which is of a homogeneous nature. It is only by modifications of the digestive system, joined with consistency, shape, mode of generation, or some extrinsic property, that the Acrite classes can be characterized.

When the nervous system begins to be distinctly eliminated in the form of fibres, it is accompanied by a distinct development of the muscular system; and the digestive canal is provided with a proper contractile tunic, and floats freely in an abdominal cavity. The nervous fibres in the classes of animals in which they are first discernible proceed from a ganglion or ganglions in the neighbourhood of the mouth, and extend in a radiated or longitudinal direction according to the form of the body, but are not afterwards brought into communication by ganglionic masses.

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* p. 1.

† Linn. Trans., vol. ii. p. 253.

‡ Rudolphi, *Beyträge sur Anthropologie*, 1812.

§ MacLeay, *Horæ Entomologicæ*, vol. i., part II., p. 202.

The Echinoderms, as the Star-fish and Sea-urchins, first present these conditions of the nervous, muscular, and digestive systems. A very gradual transition from the radiated to the elongated form is traceable from this class through the *Holothuriæ* and *Sipunculi* to the cavitary *Entozoa* or *Cœlelmintha*, (intestinal worms having an abdominal cavity,) and thence to the *Epizoa* and *Rotifera*, which make a near approach to the Annulose Division of the animal kingdom; but at the same time do not possess that structure of the nervous system which is its true characteristic. The four classes of animals, thus distinguished by a common character of the nervous system from the Acrita on the one hand, and the Articulata on the other, constitute a second division of the animal kingdom, which may be termed '*Protoneura*'.

The third type of the nervous system is accurately described by Mr. Hunter as characterizing the group which he calls Insects*. It consists essentially in the extension of two nervous chords from the inferior part of the œsophageal ring along the abdominal surface of the body, where they are united by a double series of symmetrical ganglions, varying in number according to their degree of concentration.

Besides the Centipede, Scorpion, winged Insect, and the Lobster, or Crustacean, which Mr. Hunter denominates 'Aquatic Insect', he has also placed dissections of the Leech and Earthworm in the same series, demonstrating the uniformity in the type of the nervous system which

* p. 6.

pervades the whole of these animals. Succeeding researches have shown that a similar disposition of the nervous system obtains in another class of Invertebrata, viz. the Cirripeds, or Barnacle-tribe, and that in the early stages of their existence they closely resemble the Entomostracous or inferior tribe of Crustaceans.

The several classes of animals thus grouped together by a community of structure of the nervous system, differ materially in the condition of the organs of the vital functions, but resemble one another in possessing a symmetrical or bilateral form of the body, which is more or less deeply divided into a series of segments or rings, for the most part corresponding to the number of ganglions or nervous centres within. In this primary division of the animal kingdom, which Cuvier has termed *Articulata*, MacLeay *Annulosa*, and which, to borrow a term from the condition of the ruling system of their 'organization', might be designated *Homogangliata*, the circulating and respiratory systems indicate by their variations the secondary divisions or classes*.

In the Annelidans a dorsal artery occupies the place of a heart, in which coloured, and generally red, blood circulates. In the Cirripeds a colourless blood circulates through an equally simple apparatus; in the Insects a mechanical organ with valves, but still vasiform, occupies the same situation, but the blood, instead of being returned by regular veins, is diffused throughout the entire cellular tissue of the body. In the Arachnidans and Crustaceans the dorsal vessel is concentrated into a muscular ventricle, and the venous system becomes more circumscribed.

These modifications of the circulating organs are accompanied with even greater varieties in the respiratory system, which is present in the different forms of external and internal branchiæ, of pulmonary sacs, or air-breathing tracheæ. The extent of respiration produces here the same effects as in the highest subkingdom of animals, and the Insects represent among the *Articulata,* the Birds among the *Vertebrata.*

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* The term 'Diploneura', under which the present and part of the preceding Division have recently been included, had been previously used in another sense to designate the Vertebrata, to which division it was originally applied by Rudolphi. (See *Beyträge sur Anthropologie*, 1812.)

A ring of medullary matter surrounding the œsophagus, and formed apparently, as Mr. Hunter observes, by the union of two large lateral nerves, and constituting the centre of union of ganglionic masses, which are scattered, often unsymmetrically, over the body, constitutes the type of the nervous system of a division or subkingdom of animals termed *Mollusca,* as numerous and extensive as the *Articulata,* and which, in contradistinction to them, might be termed, from the prevailing character of the ruling system, *Heterogangliata.*

The specimens which Mr. Hunter has prepared in illustration of this type of the nervous system are exclusively taken from one genus of Gastropods, the Slug, or *Limax*; but from the form here exhibited, a descending gradation may be traced to the Bivalve and Tunicary, in which the cerebral ganglions sink below the œsophagus; while a progressive development may be followed in the opposite direction to the Cephalopod, in which the brain acquires the greatest proportionate size which it exhibits in the Invertebrate series, and is protected by a cartilaginous cranium. In this class, however, the characteristic condition of the Molluscous type is still manifested in the absence of a dorsal column of medullary matter continuous with the brain, and in the substitution of diverging filaments bringing into communication ganglions dispersed at a distance from the mesial plane. The modifications of the vascular and respiratory system serve in the *Heterogangliata,* as in the *Homogangliata,* to mark the secondary divisions or classes, in conjunction with modifications of the external locomotive organs. A regular gradation may be traced from the Ascidian, in which the heart is represented by a dorsal vessel, to the Cuttle-fish, where it assumes the form of a well-organized muscular ventricle, with auricles subservient to it, and where the lesser circulation is also provided with equally complex organs of propulsion. In both the preceding divisions the generative system manifests greater variety and less regularity in its modifications than the circulating and respiratory systems, and is therefore less valuable as a zoological character. In one class of *Mollusca*, e. g. the *Gastropoda*, in which the heart uniformly presents the '*Dicœlous*' type of Hunter, or but one auricle and one ventricle, the Generative system is in some families *Androgynous*, in others *Diœcious*. It is consequently indicative of groups of inferior value to those characterized by the Circulating system.

When Mr. Hunter made the possession of a brain, proportionally larger than in the preceding divisions, protected by a skull, with a medulla spinalis continued from it down the back, and an endowment of the five senses, characteristic of his 'third Class, or Fishes', as contradistinguished from 'Insects', he seems to have failed to recognise those modifications of the nervous system as characterizing equally the Amphibia, Birds, and Mammalia, and as being, in fact, the common attributes of his fourth, fifth, and sixth classes of animals. The appreciation of the great natural group thus distinguished, and its relation to the other primary divisions of the animal kingdom, was reserved for the penetration and judgement of Cuvier.

Nevertheless in the masterly determination and description of the modifications of the Vertebrate type of the nervous system which characterize the subordinate groups or classes of that great division, Mr. Hunter has displayed his wonted powers as an original thinker and unbounded observer of the varieties of the animal structure; and one cannot sufficiently admire the close and philosophical perception of the analogies of the several parts of the brain which is manifested in this early enunciation of its comparative structure. It is hardly necessary to observe, that Mr. Hunter's determination of the middle masses in the brain of Reptiles is now generally preferred to that which Cuvier adopted.

The central axis of the nervous system, composed of brain and spinal chord, being protected by a series of bony or cartilaginous rings called *vertebræ*, the term 'Vertebrata' has been applied to this, the highest, division of the animal kingdom; and if, in conformity with the terminology proposed for the preceding divisions, an appellation indicative of the distinguishing characteristic of the nervous system be assigned, this division might be termed '*Myelencephala*'.

It is in this division that Mr. Hunter has studied most profoundly the comparative anatomy of the animal kingdom, although his investigations of the lower-organized subkingdoms were far from being of so limited a nature as some have naturally supposed, to whom his Collection has been so long, as it were, a sealed book.

In the manuscript before alluded to, providentially copied by Mr. Clift, there is the following more extended table of the anatomical characters of the classes of the Vertebrate subkingdom:

" The properties of the 'first class', which includes both sea and land animals, are

" *Heart*, made up of four cavities; essential.

" *Lungs*, divided into small cells, and confined to a proper cavity, the enlargement of which is the cause of respiration; essential. Respiration quick (and, I believe, this is the only class in which it is so); essential.

" *Give suck*; essential.

" *Parts of Generation*, made up of testes and one penis in the male: the testes sometimes within and sometimes without the abdomen, but pass forwards. Clitoris, vagina, uterus, os uteri, Fallopian tubes, and ovaria in the female; all essential.

" *Kidneys*, high up in the abdomen; circumstantial.

" *Organ of Hearing*, an external canal to the ear, membrana tympani concave externally, a cochlea; circumstantial.

" The animals of this class are by much the most perfect, whether sea or land. There is a gradation from the land to the sea animals, viz. Otter, Seal, Hippopotamus, Whale.

" The ' second class' is confined to the ' Birds' entirely. I do not know of any animal of this class but what has all the characteristics of the Bird. They vary less in any of their parts than the first class.

" *Lungs*, attached to ribs that they may move with them ; lungs perforated ; membranous bags in the abdomen that receive air in respiration ; something like a diaphragm.

" *Parts of Generation*, ova crustaceous; one oviduct; one penis, and that grooved; no bladder. Oviduct in the female, and penis with the vasa deferentia in the male, are all in the same cavity with the anus.

" *Liver*, divided into two lobes ; cyst-hepatic ducts.

" *Organ of hearing*, little external passage to the ear, membrana tympani convex externally, but one bone (ossiculum auditus) ; no cochlea.

" Feathers, wings, two legs, long neck, bill, membrana nictitans, bursa Fabricii.

" There is none of this class that belong entirely to sea animals ; but this class may be said to possess in some measure three elements, viz. air, earth, and water ; but they live no more in the air than other animals, for it is only for their progressive motion.

" In the ' third class' we shall find some parts similar to the second.

" The third class may be divided into two, for they are not exactly alike, but one seems to partake of the second and third, as it were made up of both. The first division of the third, then, is the Lizard and Serpent kind. They have

" *Heart*, two auricles, one ventricle, two aortas which unite in the abdomen.

" *Lungs*, loose bags, which lie in the thorax, and abdomen only partially divided. No diaphragm.

" *Kidneys*, in the lower part of the abdomen. No bladder*.

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* This character applies only to the Serpents.

" *Parts of Generation,* two penises grooved, which are in the tail. Some oviparous, eggs without shells; others viviparous, but not as the 'first class'.

" Some have legs, others none; some a membrana tympani, which is convex, like the Lizard, others none, as the Snake.

" The other part of this class, which may be called the 'fourth', or the Amphibious, are more closely allied to Fish than what the fish of the 'first class' (Cetacea) are. These are the common Amphibious animals, viz. Frogs, Turtles*, Efts, &c. This is also very similar to the two former, and is nearly, as it were, a mixture of both, yet the most essential parts belong, or are similar to the last.

" *Heart,* two auricles, as in the 'third'; one ventricle, as in the 'third', aorta, as in the 'third'.

" *Lungs,* as in the 'third'. No diaphragm.

" *Kidneys,* as in the 'third'.

" *Parts of Generation,* one penis, as in the 'second'; penis grooved, as in the 'second' and 'third'. Some oviparous, as the Frog; others viviparous, as the Salamander.

" *Organ of Hearing*: some have a membrana tympani, as the Frog; others none, as the Tortoise.

" The fourth or fifth class (according as the two preceding are regarded as subdivisions of one, or as two distinct classes,) consists of Fishes, and is very distinct from the former so far as I know.

" There are three classes of animals which may be called oviparous, viz. the Birds, the Amphibia, and the tribe of Ray-fish. The Birds and Amphibia are nearer each other in their operations; but in some circumstances the Ray-fish is the same as the Amphibia, in others very different. They are different, first, in the construction of their eggs, which are without any slime (albumen): they are somewhat different in their mode of receiving the yolk into the abdomen."

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* The Tortoise and Turtle, or Chelonian Reptiles, are separated from the Amphibia by modern Naturalists, by whom that term is restricted to the Reptiles that have at one period of their existence external gills as well as lungs.

With respect to the affinities between Birds and Reptiles, or Amphibia, Mr. Hunter further observes:

" The lungs of the Fowl open into their cells or bags that are in the cavity of the belly. The lungs in the Amphibia are continued into the belly, are cellular at the upper part, but in most, as the Snake, become smooth bags at the lower end, as it were, answering the same purpose as the abdominal bags in the Fowl. The cells of the lung-part are large. No proper diaphragm in either. But Fowls have something similar to one. The gall is green in both. The kidneys are placed in what may be called the pelvis; in both are conglomerated in a particular manner; have the ureter ramifying through their whole substance, and entering into the rectum. The urine is a chalky substance in many of both, and a kind of slime in others. The testes are situated in the abdomen in the male of both. The vasa deferentia enter the rectum in both. Penis grooved in both. Both oviparous: structure of ear similar; heart very different."

These writings sufficiently attest the enlarged views which Mr. Hunter entertained of comparative anatomy, and of its application to the establishment not only of sound theories of the functions and relative influences of the different organic systems in the same animal body, but of the chain of affinities by which all animals are linked together in one great and harmonious system. It is in this respect that he has chiefly surpassed those of his countrymen who have immediately succeeded him in the same field of inquiry, and whose labours have been productive of inadequate results, chiefly from being unassociated with a knowledge of Zoology, and from being restricted to the narrower channel of their physiological application.

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[*] Πρῶτος, *primus,* νεῦρον, *nervus.* The animals in which the nervous system is first discernible in the form of simple filaments unconnected except at their origin.

[†] Ὁμὸς, *similis,* γαγγλίον, *nervosum tuberculum.* The animals in which the body is supplied by two nervous chords and series of ganglions similarly or symmetrically disposed, as the Articulata of Cuvier and the class Cirripedia.

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* Ἕτερος, *dissimilis*, γαγγλίον, *ganglium*; the animals in which the body is supplied with nervous filaments and ganglions for the most part irregularly or unsymmetrically disposed, or the Mollusca of Cuvier with the exception of the Cirripedia.

† Μυελὸς, *medulla*, ἐγκέφαλος, *cerebrum*; the animals in which the body is supplied with nervous chords and ganglions communicating with a central axis formed by a brain and spinal marrow, which are protected by a skull and vertebral column.

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ORGANS IN PLANTS AND ANIMALS FOR THE SPECIAL PURPOSES OF THE INDIVIDUAL.

SUBDIVISION VII.

NERVOUS SYSTEM.

" *General Observations upon the Brain.**

" THE Brain is a viscus not common to all objects endowed with animal life, and is therefore not essential to such life. It is only essential to

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* There is perhaps no department of anatomy in which greater advances have been made since the death of Mr. Hunter than in the Nervous System, both as regards the knowledge of the details of the various modifications which it presents in the animal kingdom, and with respect to the determination of its functions. It could hardly, indeed, be expected that his observations on this system, or any of its parts, would be characterized by the same depth and completeness as are manifested in his writings and preparations relative to the structures in which he was more immediately interested, viz. those relating to the vital functions.

Nevertheless, the following pages will show that he had at least obtained a glimpse of all the those which have sensation, and a will of action called voluntary motion, or simple consciousness of themselves; but in those which have no knowledge or consciousness of themselves, and therefore have no will, there is no brain: and we find it a pretty general rule that this viscus bears in size a degree of proportion to those qualities.

" Its situation is in the head in all the animals that I am acquainted with.

" Brains differ from one another very essentially in their component parts, and these differences constitute one of the classical distinctions of the various tribes of animals.

" A whole brain in the more perfect animals is made up of several parts, all united together in a common base; but in the more imperfect animals, as the Snail, Lobster, &c., it appears to be but one substance or part. These parts are more or less compacted in different animals; most so in the most perfect, but becoming less and less so in the more simple animals.

" In our first (or highest) order of animals the close union of the different parts is more remarkable; and still more so in the Human subject, where the brain is brought into a round figure, taking up as little space as possible; which allows the head to be of so small a size considering the quantity of brain.

" The shape varies in different animals, and even in those of the same class, such as the Quadrupeds, the brain being in some rounder, in others more oblong, answering to the shape of the head and perhaps to other external circumstances; therefore shape is not essential to the purposes of the brain.

" This viscus varies in size in some degree in proportion to the perfec-

leading modifications of the sensitive apparatus, and had accurately traced the component parts of the brain through their singular metamorphoses in the highest classes of animals without losing sight of their true analogies; of which, indeed, had the present manuscript been published in the lifetime of the author, it would have contained the earliest enunciation. Therefore, and as every idea emanating from so strong and original a mind cannot fail to be both interesting and instructive, it is here given with a few verbal corrections merely, and with such notes as may prevent an erroneous conception in the mind of the student on any important point relating to the nervous system. (The original notes are indicated by inverted commas.)

tion of the animal. In the more perfect classes of animals it is much larger in proportion to the size of the body than it is in any of the less perfect. In the first it makes a very considerable part, while in the last it bears a very small proportion to the whole body. However, in some classes of animals there is a very considerable difference among themselves, some having very large brains in proportion to others ; but I believe that this difference in the size of the brain, in the same class, is greatest in the most perfect class; however, those animals which have the largest brains are very few in number in comparison to the others. The Human is perhaps the first of this class; and of all the animals that I have examined the Porpesse and the Elephant come next.

"In the first (or highest) class, the brain would seem to be much more complicated than in the others, having many more parts : all have one common root, having three considerable masses placed upon it, which compose the whole brain : two of these are similar to one another, and therefore may be considered respectively as half a mass ; the third is uniform, and a complete body.

"The brain in all the animals of this class is much more vascular than in the inferior classes, and the Human brain is by much the most vascular of any.

"The vessels creep and ramify upon the external surface, dividing into smaller and smaller branches, and never enter the substance itself, till they have arrived at their ultimate ramifications, not appearing to divide afterwards. For the admission of the larger vessels to the deeper-seated parts, the division of the brain into different parts, especially in the larger kinds, is well adapted. But besides this, the external surface is frequently divided by deep sulci, the eminences between which are called 'convolutions', and these sulci are deep in proportion to the distance from the surface to the centre of the brain ; it is therefore convoluted in some and not in others, and the convolutions are, of course, more or fewer, and are also deeper or shallower, in proportion to the size of the brain. In the Human* they are very deep ; likewise in the Porpesse†, in the Ox‡, &c. they are also

* No. 1339. † No. 1333. ‡ No. 1328.

pretty deep; but in the smaller animals, as the Beaver*, there are hardly any convolutions. The intention of the convolutions would appear from these circumstances to be only to form passages between them for the blood-vessels, so that large trunks of arteries need not pass into or through the substance of the brain.

"The substance called brain is similar to nothing else in the animal. It appears to be a homogeneous mass, composed of no other substance than one, being uniformly the same through the whole. It has no direction of parts, or fibres†, and breaks or tears equally in every direction. Although not very solid, yet its attachment of cohesion is pretty firm, not being easily broken or washed away. In consistence, and many other circumstances attending consistence, it comes nearest to that of moist clay of any substance I know.

"The whole, considered together, is made up of two different-coloured substances, one darker than the other. The three large parts of which we have been speaking have the dark substance on the outside, but the root, or union of the whole, is made up principally of the white, or is the common union of all the white parts. The external is called 'Cortical', which is a bad name, as it is not always on the outside; the other is called 'Medullary', which, for the same reason, is also a bad name.

" *Of the first Class of Animals that have Organs of Sense and consequently have Brains.*‡

"The brain in this class of animals is scarcely similar in any respect to that of the most perfect animals with which we are in general more acquainted. It consists of a pulpy substance, somewhat transparent, which is easily squeezed out when the brain is cut into. It appears in some, and perhaps in all the lower classes that have brains, in the shape of a ring, from the circumference of which arise the nerves, as radii from a centre. Through this ring (in such) passes the œsophagus. I am apt to believe, however, that this ring is not wholly brain, but a union of two large lateral nerves, which unite under the œsophagus. This at least appears to be the case with the next class. It is not inclosed in hard parts, and is not defended from pressure or injuries more than any other internal part.

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* No. 1323 F.

† It is scarcely necessary to say that later researches on this subject have uniformly tended to establish not only the fibrous structure of the brain, but the regular arrangement of its fibres: it would also appear from Nos. 1335, 1336, that Mr. Hunter had subsequently discovered a more definite structure than he describes above.

‡ The preparations (Nos. 1304, 1305, 1306,) which in the original manuscript Catalogue illustrate the condition of the nervous system characteristic of this 'class' are derived exclusively from the Molluscous subkingdom of Cuvier, whence it may be inferred, that Mr. Hunter had a perception of that great natural subdivision of the animal kingdom.

" This class would appear to have but two senses, viz. feeling and taste, having neither seeing nor hearing, and most probably without the sense of smell. There appears to be no organ for such a sensation, and the respiratory organ is so situated as not to be of any service to taste, to which smelling is certainly a director *.

" *Of the Second Class, or Insects.*

" The class of animals immediately superior in sensation to the foregoing is (I believe) that class called 'Insects,' both aerial and aquatic. We find in them an increase of senses. The first class we were inclinable to believe had but two senses; but here we are pretty certain of four, viz. touch, taste, hearing †, and sight: how far they have smell I have not been able to discover, but should doubt it ‡.

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* The same circumstance obtains in Fish, in which, however, there is a distinct organ of smell; the odoriferous particles suspended in water affecting a plicated pituitary membrane supplied by large olfactory nerves. Cuvier suggests, that the external integument of the Mollusks may possess a similar faculty; and a distinct olfactory organ analogous to that of fish, has since been discovered in the Cephalopodous Class.—(Memoir on the Pearly Nautilus, p. 41.)

With respect to the sense of hearing, traces of a distinct auditory organ have only been met with in the higher order of Cephalopods, which it may be doubted whether Mr. Hunter considered as distinct from Fishes. But in the Mollusks which he has selected in illustration of the type of the nervous system of his first class of animals having senses, viz. the Slug, the rudimentary eyes supported by the upper tentacles have been subsequently determined to possess the chief parts characteristic of the visual organ; and in other Gastropods, as the large *Strombi, Murices, Volutæ,* &c. the corresponding visual organs have been distinctly ascertained to possess a retina, crystalline lens, pigmentum nigrum, iris, pupil, and sclerotica.

" † It is pretty certain that Bees hear."

" ‡ Yet it would appear from observation that it is very probable that Bees and Wasps have smell."

" The brain lies in the head of the animal, and consists of a small rounded body, giving off nerves in all directions to the different parts about the head, such as the optic nerve, &c. The brain is a pulpy substance, somewhat transparent, which gives it a blueish cast. From the posterior or lower part of the brain, close to one another, go out two large nerves ; one passes on each side of the œsophagus, and they then unite into one, forming a knot at this union*. They disunite again, and so unite and disunite alternately through the whole length of the animal, at every union giving off the nerves, as from the brain. This structure I suspect answers both the use of a medulla spinalis and the great intercostal nerve†.

" *Of the Third Class, or Fish.*

" This class of animals is a considerable remove from the former in complication of structure. We have observed that they have a complete circulation, making in the whole almost a second.

" They are endowed with five senses.

" The brain in this class is, upon the whole, much larger in proportion to the size of the animal than in the former. It is a very irregular mass ; but the several parts that are similar to these in a still superior order may be picked out. The brain varies in shape in this very much more than in any other class of animals. The cerebrum in some, as in the Skate, is detached to some distance from the other parts ; in others it

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" * It is the union of these two nerves, and the œsophagus passing through between them, which made me suppose that that in the Snail was a similar structure."

† The complicated abdominal cord of Insects has since been accurately figured and described by Lyonet and other anatomists, and has recently been successfully studied in relation to the modern discoveries of the functions of the several parts of the spinal chord of the vertebrate animals. Mr. Newport (*Phil. Trans.* 1834, p. 405.) describes the abdominal cords of insects as composed of two tracts, a ganglionic or sensitive which is anterior or ventral, and a motor tract which passes over the ganglions on the posterior or dorsal aspect. In addition to these there is a narrower column on the posterior part of the motor tract, which he calls the involuntary tract, and would therefore more immediately answer to the sympathetic or great intercostal nerve. These parts in the Crustaceans and in the imago of the Insect are protected by a specially investing substance, of which Mr. Hunter appears to have been aware from his assigning the floating or unprotected condition of the nervous centres as a character of his first class.

is pretty closely connected. There are more parts in some than there are in others.

" They have a medulla spinalis, or continuation of the brain down the back.

" In the first class we had the brain surrounded by soft parts only. In the second it was closely surrounded by soft parts, but these were surrounded by hard. In the present class the brain has a case of hard parts for itself, called the skull; but it is too large for the brain, therefore this is attached to the skull by a cellular membrane, which makes a kind of tunica arachnoides*.

" The nerves arising from the brain in this class are very large, and there seem to be nine pairs.

" *Of the Fourth Class, or Amphibia.*

" The brain in this class is very small in proportion to the size of the animal, smaller than even what it is in the former, or Fishes.

" It would seem from external appearance to be made up of many parts, which are not hidden, or do not lie one upon another, but are very much detached and follow one another, or are more in one line or direction, and not compacted. The whole is an oblong body composed of five eminences, with their common basis.

" The two anterior consist of the cerebrum; the two middle I should suppose of the nates and testes, which I suppose to be the middle lobes detached; because, in the Bird, they are more underneath, not so much between the cerebrum and cerebellum. The posterior is the cerebellum, consisting of one body entirely.

" It would appear as if the order of size was inverted, viz. the two middle bodies seem to be the nates and testes, yet they are much too large to bear the same proportion as in the higher classes. Every eminence has a cavity or ventricle in it, therefore, in this class, there are five cavities or ventricles. The cavities in the cerebrum are larger than in the others, and are similar to those of the higher classes, i. e. they have a large eminence projecting into the cavity, which is the major part of the brain in the Bird. In the others the cavities seem to be pretty near of the shape of the body or protuberance in which they are; and they are very large in proportion to the size of the brain. The tunica arachnoides covers almost the whole brain. It does not adapt itself to the eminences and cavities, but is connected with the pia mater by a cellular membrane on its inside, and to the skull, or dura mater, on its outside.

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* The mode of progression of fishes requires that the head should be of large size, to divide the water and to afford adequate attachment to the mass of muscles passing to it from the body. The mode in which this is effected without incurring an undue accumulation of ponderous matter about the brain, is now universally acknowledged to be that which Mr. Hunter has described, viz. by an extraordinary development of the arachnoid covering, the cells of which are filled with a serous fluid; and upon this is the skull moulded.

“ There are no convolutions on the external surface of the brain, but it is covered smoothly by the pia mater.

“ The nerves arising from these brains are very large, nearly as large as in the human.

“ There are ten pairs that go out of the skull, and the accessorius joins the ninth pair.

“ The first pair are very large at their beginnings becoming very small at once, which has the appearance as if they arose from two small round bodies.

“ Although the Crocodile is classed with the *Amphibia*, and really comes nearer to that class than to any other that I know of, it has not all the same character, as has been observed. It comes nearer the Bird than any of the other Amphibia, and therefore is a degree higher*. The brain, although it has the same parts, yet it has them closer connected, and the skull is more in contact with it.

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* The justness of this observation is confirmed by the systems proposed by many modern naturalists for the classification of the Amphibia of Linnæus. M. De Blainville separates the Crocodiles from the other Sauria of Cuvier, to form a distinct order, which he terms ‘Emydosauria’. Merrem makes a similar distinction, and terms the order ‘Loricata’. Latreille also separates the Crocodiles from the Lacertæ, but joins them with the Chelonians to form his section *Cataphracta*. Mr. Gray joins the extinct Saurians or *Enaliosaurii* with the Crocodiles to form his order ‘Loricata’.

“ *Of the Fifth Class, or Fowl.*

“ The brain in this class is larger in proportion to the size of the animal than in the foregoing. It consists of the pulpy substance, but is not very distinctly of two kinds, cortical and medullary.

“ It would seem to be made up of six parts, viz. the two hemispheres of the cerebrum; the two round bodies, one on each side of the medulla oblongata, pretty much detached, which would seem to answer for the two middle lobes, although their situation with respect to the skull is different, for they are under the lateral processes; fifth, the cerebellum; and sixth, the medulla oblongata, which is the common base. The cerebellum is considerably behind the posterior lobes, and is large in proportion to the size of the whole brain.

“ The two hemispheres do not seem to unite, although they are so close to one another as to be hardly separated by means of the inner sides of the two lateral ventricles. The two lateral ventricles are very large, and may be called the broad cavities; they begin forwards near the anterior points where the olfactory nerves arise, and near that surface where the two hemispheres are in contact with one another; each ventricle passes backwards, and winds round the posterior end, but does not extend so far to the outer or lateral parts of the hemisphere as to come forwards again. The part of the brain which makes the inner and posterior wall of this cavity is very broad, and so thin in many places as to appear like a membrane or pia mater only. On the inner surface it is concave, on the external it is convex, and the opposite or inner side of the cavity, which is the major part of the brain, is convex, which answers to the concavity of the outer; so that the two surfaces are moulded to, and in contact with, one another. When this outer portion is taken off, the brain is nearly of the same shape and size as before. The plexus choroides is a vessel which comes from the lower part of the cavity of the two thalami, or from the upper surface of the medulla oblongata, and runs backwards and upwards through the cavity, and spreads into a broad loose flat fringy end. At the lower part of the division of the two hemispheres is the third ventricle, like a groove; the anterior end terminates in the infundibulum below the optic nerves, but at some distance; the posterior end is continued into the fourth ventricle in the quadruped, or the sixth ventricle in this class.

"The two lateral bodies* which are on the sides of the medulla oblongata, and somewhat under the posterior lobes of the cerebrum, somewhat in the situation of the cerebellum in the next class, are equal in size to one sixth of the whole brain. They have each a cavity in the middle, which make the fourth and fifth ventricles, and these communicate with, or enter at, the communication of the third with the sixth, so that all those six ventricles communicate with each other.

"The cerebellum is a prominent pyramidal body, standing on the posterior and upper part of the medulla oblongata, behind and somewhat between the posterior lobes of the cerebrum and in contact with them: it is more convoluted than the cerebrum, which convolutions are sometimes similar to the human.

"*Of the Sixth Class, or Quadrupeds.*

"The brain in this class is, in general, larger than in the preceding, and the parts more compacted, the whole mass being brought into nearly a globular figure.

"The cerebellum is more immediately under the cerebrum, and the convolutions in the cerebrum are deeper.

"The nates and testes are four small bodies, with no visible cavities, which are not seen externally, but lie at the posterior end of the third ventricle.

"The ventricles are only four in number†. The two lateral ones communicate under the lower edge of the septum lucidum, and are pretty large; beginning in the anterior lobe of the cerebrum by a blunt end pretty far forward, going directly back, and when got some considerable way, bending outward and downward, then forward and still down- and also in-ward, and ending nearly under their origins. In them lie the corpora striata, the thalami nervorum opticorum, the plexus choroides, and the fornix. The third ventricle is directly under the fornix, and communicates forwards by a small opening with the infundibulum, which goes down to the pituitary gland; behind, it communicates with the fourth ventricle, which is partly in the medulla oblongata.

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* The optic lobes, or bigeminal bodies.

† The interspace between the layers of the septum lucidum is now regarded as constituting a fifth ventricle, and is peculiar to the Mammalia.

"The cerebrum and cerebellum end by four peduncles in the tuberculum annulare, and the medulla oblongata goes out from it; at the going out of which are four pyramidal bodies, viz. the corpora olivaria, and corpora pyramidalia.

"In the brain the cortical substance is on the outside, in the medulla spinalis within; in some it is in one line running down, in others two.

"The nerves which go out of the skull are nine pair, and the accessorius, which goes out with the eighth." *Hunterian Manuscript Catalogue.*

SERIES I. Nervous System of the Nematoneura.

SUBSERIES 1. *In Echinoderms.*

1292 A. A Star-fish (*Asterias papposa,* LAM.), with the membrane removed from the oral surface of the central disk to show the simple nervous chord surrounding the mouth and distributing filaments to each ray. These filaments run in the interspace of the tubular feet, extending from between the spines which protect the ambulacral grooves.

Prepared by Mr. Owen.

2. *In Cœlelminthans.*

1292. The anterior part of a Sipuncle (*Sipunculus phalloides,* PALL.), with the viscera removed and the integument inverted to show the nervous chord. This commences in the form of a ring surrounding the entrance of the alimentary canal, from the ventral aspect of which ring a simple chord extends in a straight line the whole length of the body. Small portions of bristle are placed beneath this chord.

1293. A portion of the nervous chord* of the same species of Sipunculus, showing the origins of the nerves distributed to the body: these are given off at pretty regular intervals of about a line and a half, but without the interposition of ganglions.

1294. The anterior part of the Round Intestinal Worm (*Ascaris lumbricoides,* Linn.) laid open and the viscera removed to show the nerves.

The parts which Mr. Hunter so regarded are the two simple white chords or bands which are seen commencing from the mouth, where they are united by a transverse band, and extending down the sides of the body.

(A portion of the internal or transverse layer of muscular fibres has since been removed from the middle of the abdominal surface to show a smaller white chord, situated between this layer and the longitudinal muscular fibres.)

1294 a. An *Ascaris lumbricoides,* laid open along the back, and the viscera removed, to show the nervous chords. The two lateral bands so considered by Hunter and Cuvier† are plainly exposed throughout their whole length; they adhere by one side to the integument, present no appearance of a ganglionic structure, and give off no apparent branches.

The smaller chord which runs along the middle of the abdominal surface is also exposed throughout the greater part of its course: it is also simple, or without ganglions, but does not adhere to the integument, and in its relative size, situation, and connexions, bears a closer analogy to the nervous system of the higher organized worms.

Prepared by Mr. Owen.

1294 b. A Kidney-worm (*Strongylus Gigas,* Rud.) laid open, and the viscera in part removed, to show the nervous chord. This is of a simple structure, and ventral in position like the mesial chord of the Ascaris displayed in the preceding specimen. It commences by a ring surrounding the œsophagus, below which a small ganglion is formed; then it continues as a straight and apparently single chord along the middle of the abdominal integument to the anus; anterior to which it also forms a small swelling, and sends off two branches larger than any that are given off previously, and analogous to the ring formed at the opposite end of the body.

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* This part has since been described as a vessel, but we have ascertained the correctness of Mr. Hunter's opinion by microscopical examination, which shows that it is a solid fibrous chord.

† *Anat. Comparée,* tom. ii. p. 357.

Prepared by Mr. Owen.

1294 c. A specimen of *Linguatula tænioides*, Cuv., laid open along the dorsal aspect and dissected to show the nervous system. This displays a higher stage of organization than the preceding specimens, in as much as the nerves of the body, though simply filamentous, are given off from a large and well-developed ganglion: this is situated immediately behind the commencement of the alimentary canal, and is therefore subœsophageal. Small nerves radiate from it in all directions to supply the muscles moving the hooks which are placed at the sides of the mouth; and two large branches are sent off posteriorly, which pass over the seminal and ovarian tubes before becoming attached to the integument. These nerves run down about a line distant from the mesial line of the abdomen, at first slightly wavy in their course, but afterwards continuing straight down to the opposite end of the body, becoming gradually less distinct, and being ultimately lost in the muscular tissue. *Prepared by Mr. Owen.*

Series II. Nervous System of the Annulosa, or Homogangliata.

1. *In Anellidans.*

1295. A Leech (*Hirudo medicinalis*, Linn.), with the stomach distended with blood, and the ventral parietes of the abdomen dissected off, showing the two abdominal nervous chords in close apposition, and united by a series of ganglions, corresponding in situation to the divisions of the stomach, the pulmonary sacs and seminal vesicles, but not to the segments of the body as marked by the exterior transverse divisions. The chords separate below the mouth, pass on each side the œsophagus, and unite above it to form a small brain or supraœsophageal ganglion. In this preparation a portion of the dorsal vessel is exposed, and a bristle inserted into it; a bristle is also placed in one of the lateral or pulmonary vessels.

1295 A. A Sea-leech (*Pontobdella muricata,* Leach), with the ventral parietes of the abdomen removed, showing a portion of the abdominal nerves, their ganglions, and lateral branches. The ganglionic unions do not correspond to the number of the transverse divisions which appear externally as segments, but occur at intervals of three or four of these divisions. The separation of the lateral columns is most obvious at the anterior part of the body. *Presented by Sir C. Pegge.*

1296. An Earth-worm (*Lumbricus terrestris,* Linn.), with the ventral parietes of the abdomen removed to show the nervous chords, their ganglions, and lateral branches. The divergence of the two main lateral chords in order to pass to the dorsal aspect of the œsophagus is plainly shown.

1297. A Sea-mouse (*Aphrodita aculeata,* Linn.), with a strip of the ventral parietes of the body removed to show the corresponding nervous chords, ganglions, and lateral branches. The distinction of the two main lateral chords may be more easily perceived in this species in the intervals of the ganglia, which also correspond to the number of segments. The left chord is traced ascending by the side of the œsophagus to its superior or dorsal aspect, where it again joins its fellow to form a small ganglion, or brain, which supplies the organs of sense; these are here represented by small antennæ, consisting each of a nerve covered by a production of the integument, which is of a finer and probably more vascular texture than the rest.

2. *In Insects.*

1298. A Centipede (*Scolopendra morsitans,* Linn.), with the integument and muscles removed from one side so as to give a lateral view of the nervous system. The Hunterian description of this specimen is as follows: "Centipede—the brain a small roundish body laid bare: the two great nerves going to the tail with ganglions at the places where they give off nerves, as in the Lobster." The part above alluded to as the brain is the large sub-œsophageal ganglion: the union of the two diverging chords above the gullet to form the true cerebral ganglion is not shown. The anterior or ventral position of the ganglions, and the nerves given off from them, and from the motor chords behind them, are well shown in this preparation.

1299. The larva of a Moth, the brain and nerves dissected through their whole course. In this beautiful preparation may be noticed, first, the large size of the ganglionic masses as compared with the filaments which they bring into communication; secondly, the divergence of the main filaments between the cerebral and first subœsophageal ganglion for the passage of the œsophagus; thirdly, the close approximation of the first and second subœsophageal ganglions; and fourthly, the divergence of the lateral chords between the second and third, and the third and fourth ganglions.

3. *In Arachnidans.*

1300. "A Scorpion; the brain dissected, which is a ring, the nerves going out as radii from a centre." This description does not exactly accord with the appearances presented by the preparation. The principal branches continued from the œsophageal or cerebral ring are three in number, which pass along the ventral aspect of the alimentary canal, and are united in their course by ganglia, of which four are here exhibited*.

4. *In Crustaceans.*

1301. A Lobster (*Astacus marinus*, Linn.), dissected so as to show from the ventral aspect the brain and subabdominal chords and ganglions through their whole course.

The origins of the ophthalmic and antennal nerves are shown, also the divergence of the main chords for the passage of the œsophagus, the intervals between the chords connecting the separated ganglions in the region of the thorax, and the close apposition of the lateral chords in the remainder of their course.

1302. "A Lobster; the brain taken out, with the eyes, and the two great nerves through their whole course to the tail, giving off a branch to each foot, and a ganglion at each place of giving off."

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* For the complicated structure of these chords and ganglia, see Mr. Newport's Paper in the *Phil. Trans.* 1834, p. 408.

1302 A. "The nervous system of the common Lobster (*Astacus marinus*, LEACH), showing the anterior and posterior, or motor and sensitive tracts, which constitute the cerebro-spinal column. The anterior or motor tract passes over the sensitive or ganglionic, and gives off, beyond the ganglia, series of small nerves, which are distributed to muscles, and appear to be analogous to the respiratory of vertebrated animals."—*Description by the Donor, George Newport, Esq., dated October the* 10*th*, 1833.

It will be seen that the ganglionic tract analogous to the sensitive or posterior tract of the Vertebrata is placed on the ventral aspect of the chord.

1303. The cerebral or supraœsophageal ganglion, with the eyes and principal nerves given off from the ganglion exhibited *in situ*, from a Lobster.

1303 A. A *Scyllarus antarcticus*, with the nervous system exposed from the dorsal aspect. In this preparation may be observed the great length of the optic nerves consequent on the position of the eyes, and also the extent of the lateral chords surrounding the œsophagus. Of the superior thoracic nerves the left is shown in part of its course; these are given off from the first subœsophageal or ventral ganglion, and pass at first outwards and then downwards along the upper part of the branchial cavity. Beyond the first ventral ganglion the two principal chords diverge, and form on each side a series of four lateral ganglions, which, with the ganglions formed by the reunion of the chords, supply the feet. This part of the nervous tract is inclosed in a series of calcareous arches, which defend the chords and ganglions from the pressure of the superincumbent viscera. The chords are then continued down the post-abdomen, forming ganglions at each segment, as in the Lobster,—of which the last or anal ganglion is the largest, as it is destined to supply the nerves to the caudal lamellæ.

A bristle is passed through the anus. The stomach is naturally inverted, so that the gastric teeth are protruded externally like the teeth in the proboscis of the Nereidæ, to which the so-called stomach of the Crustacea may be compared. *Prepared by Mr. Owen.*

1303 B. A Hermit-crab (*Pagurus pedunculatus*, OLIV.) dissected for the nervous system. The cephalic ganglion is of large size and transversely quadrate in form: the origins of the large nerves which it gives off to the eyes and antennæ are shown. The lateral chords unite below the alimentary canal to form a ganglion, which supplies the maxillary apparatus; the chords then form a large oblong ganglion situated at the base of the chelæ and extending to the origins of the second pair of ambulatory feet, both of which pairs it supplies. The lateral chords, greatly enlarged, separate from each other for a short distance, and reunite to form a third ventral ganglion, smaller than the second, which supplies the third pair of ambulatory feet and gives off posteriorly three pairs of nerves. Of these, the lateral pair supply the fourth diminutive pair of feet; the mesial pair, the fifth; and the dorsal pair, of extremely minute size, are the continuations of the main chords, and pass along the concave side of the soft membranous post-abdomen to the anus, anterior to which a small ganglion is formed, which gives off the nerves to the caudal lamellæ, here converted into claspers, enabling the animal to adhere to the columella of the univalve shell which it may have selected to protect that part of its body which nature has left undefended by a crustaceous covering.

Prepared by Mr. Owen.

SERIES III. Nervous System of the Mollusca, or Heterogangliata.

SUBSERIES 1. *In Acephalans.*

1303 c. An Ascidian (*Cynthia tuberculata*, NOB.). The internal elastic covering and part of the muscular tunic have been removed to show the nervous system. This commences by a filamentary ring surrounding the commencement of the alimentary canal, through which a bristle is passed; the nervous filaments proceed to the interspace between the branchial and anal orifices, and then are connected with a large ganglion, behind which a bristle is placed. Nervous filaments radiate from this ganglion, and the principal branches encircle the branchial and anal orifices.

Prepared by Mr. Owen.

2. *In Gastropods.*

1304. A Slug (*Limax rufus*, Linn.) laid open longitudinally along the back, and the viscera removed, to show the nervous system. In this, as in other Encephalous Mollusks, a well-developed ganglion is situated above the œsophagus; it is of a transverse shape, slightly enlarged at its extremities, and supplies the antennæ or horns, and the eyes. The œsophageal nervous ring is completed by a larger ganglion below the tube, from which numerous nerves radiate to supply the body. The principal nerves are the two inferior ones, which extend on either side the mesial line of the ventral surface straight to the opposite end of the body, giving off nerves to the muscular disk or foot from their outer sides. A small unsymmetrical ganglion is formed on the nerve which supplies the heart and respiratory apparatus.

1305. The same species of Slug laid open along the ventral aspect, and the viscera removed, to show more especially the subœsophageal ganglion and its nerves. A bristle occupies the place of the œsophagus.

1306. The nervous system of a Black Slug removed from the body.

3. *In Cephalopods.*

1306 a. The head and anterior or muscular part of the body of the Pearly Nautilus (*Nautilus Pompilius*, Linn.), laid open longitudinally along the dorsal aspect, and the sides divaricated, to show the nervous system.

The brain, or supraœsophageal mass, consists of a transverse chord-like ganglion, from the ends of which three nervous trunks are continued on each side. The anterior pair pass downwards and forwards by the sides of the œsophagus to unite below it, forming a ganglion on either side, which supply the digital processes and tentacles, and give off nerves to the organ of smell and the funnel. The middle and superior trunks dilate into the optic ganglions; the retina, which terminates that of the left side, is shown. The posterior chords surround the œsophagus in a manner analogous to the anterior pair, forming also two ganglionic swellings, from which the nerves of the great shell-muscles and those of the viscera are given off; the latter nerves are of small size and are continued down by the side of the great perforated vein, and are analogous in their distribution to the sympathetic nerves and par vagum. See Plate XXXI., and Memoir on the *Nautilus Pompilius,* p. 36.

Prepared by Mr. Owen.

1306 B. The head of a Cuttle-fish (*Sepia officinalis,* LINN.) dissected to show the brain and principal ganglions and nerves.

The high development of the cerebral ganglions, and the protection afforded to them by a cartilaginous cranium, indicate a type of the nervous system distinct from and superior to that of the Gastropods: but the Cephalopods cannot in this respect be separated from the lower Mollusks as a distinct division of the animal kingdom, on account of the intermediate form of the nervous system in the Nautilus, by which the transition from the Gastropods to the Cephalopods is effected.

The general disposition of the nervous system in the Sepia is the same as in the Nautilus, modified chiefly by the augmented volume of the cerebral or supraœsophageal mass and of the optic ganglions. As the superior locomotive energies of the Cuttle-fish demand more perfect vision, the centre to which the impressions of the optic ganglia are referred is accordingly more highly developed. Upon the optic peduncles may be observed two small spherical bodies, probably analogous to the cerebral glands in the Vertebrata.

The anterior subœsophageal ganglia give off nerves to the brachial and labial processes; the posterior subœsophageal ganglia send off mesially the nerves analogous to the sympathetic, which supply the viscera; and laterally the large nerves which pass outward to the mantle, and then form on either side the great ganglion, which, from the radiated distribution of its filaments, is termed ‘ganglion stellatum.’

Prepared by Mr. Owen.

1307. A section of the mantle of a large Cuttle-fish (*Sepia officinalis,* LINN.), showing one of the lateral nerves with the ganglion stellatum. Before the formation of the ganglion the lateral nerve divides, and one division is continued, without being implicated in the ganglion, through the substance of the mantle to the muscular fibres of the lateral fin. A bristle is placed behind this portion of the nerve.

Series IV. Nervous System of the Vertebrata, or Myelencephala.

A. *STRUCTURE OF THE BRAIN.*

Subseries 1. *In Fishes.*

1308. The cranium of a Cod-fish (*Gadus Morrhua,* Linn.) laid open, with the brain *in situ,* showing its small size in proportion to the cranial cavity. The wide interspace resulting from the continued increase of the skull after the brain has attained its full size, is occupied, as Mr. Hunter describes, by a cellular arachnoid membrane.

1309. The brain of a Fish. "The cerebrum fissured; the cerebellum, a long projecting body, also fissured in a less degree; the nates two projecting bodies; the optic nerves decussate one another."

The anterior or cerebral lobes are the smallest which present themselves on a superior or superficial view; the large lobes posterior to them have been recognised as the homologues of the bigeminal bodies by most comparative anatomists since the time of Hunter. The cerebellum is defective in the lateral lobes, and its surface here presents a simple longitudinal mesial fissure; but its relative size is considerable. Besides the bodies noticed in the original description, there are on the inferior surface of the brain two hemispherical bodies, which have been regarded as identical with the corpora mammillaria or candicantia. They are separated by a small tubercle, anterior to which is the place of attachment of the pituitary gland.

1309 a. The brain of a Sturgeon (*Acipenser Sturio*, Linn.), with the principal nerves and commencement of the medulla spinalis. The cellular arachnoid and thick pia mater have been removed: that part of the latter which covers the fourth ventricle has been cut through and turned aside, showing the medullary striated laminæ on its inside. The true cerebellum is of very small size and covers only the anterior part of the fourth ventricle; before it are the optic lobes, closely united at their mesial surfaces so as to appear like one body, but with their cavities or ventricles separated internally by a mesial septum: the left ventricle is laid open. The cerebral lobes are very small elongated bodies. On the basilar aspect of the brain may be seen the commissure or union of the optic nerves, behind which are the corpora candicantia and the large pituitary gland.

Prepared by Mr. Owen.

1310. The brain of a Skate (*Raia Batis,* LINN.) and of a Torpedo (*Raia Torpedo,* LINN.) *in situ*; prepared to show the differences in the nerves arising from the brain. These differences consist in the smaller size of all the cerebral nerves of the Torpedo, with the exception of the fifth and eighth, which are prodigiously developed, and render to the peculiar electrical organs of this species. The size of these nerves is accompanied with a proportionate enlargement of the medulla oblongata, of which only a small part is covered by the cerebellum. This body, on the other hand, is relatively of less size than in the Skate, but its exterior is similarly marked by a crucial fissure: the small dimensions of the optic and olfactory lobes in the Torpedo accord with the small size of their respective nerves.

The original Hunterian description of the brain of the Skate is as follows: "The cerebrum is detached and not divided by a fissure; two nates; and as if two nates on the cerebellum; cerebellum a prominent protuberance."

In both species the cavity of the cranium is larger than the brain which it contains; and the interspace is occupied, as in the Cod, by a cellular arachnoid membrane.

1311. The brain of a Shark (*Galeus communis,* CUV.). This brain in the number and general proportions of its different parts resembles that of the Ray. The cerebellum is, however, more highly developed, its surface being increased by several transverse fissures, and it advances forwards so far as to cover part of the optic lobes. The olfactory or cerebral masses are extended transversely, and give off from their outer angles the olfactory nerves, which are large and short, and dilate into an oblong ganglion before dividing into the filaments which supply the lamellated pituitary membrane. The optic nerves are conjoined at their origins, as in the Skate; behind these are the pituitary gland, which is of large size, and the corpora mammillaria, divided transversely, so as to form four hemispheric protuberances. The origins of the third, fifth, sixth, seventh, and eighth nerves are also shown; the glossopharyngeal, arising separately from the par vagum, forms a ninth pair; but the homologue to the gustatory nerve of the higher classes is wanting. The corpora restiformia are divaricated to show the cavity of the fourth ventricle.

1311 A. A portion of the brain, including the cerebellum and medulla oblongata, of the Basking Shark (*Squalus maximus*, LINN.). It is well adapted, from its large size, to show the complicated structure of the cerebellum peculiar in the class of fishes to the higher organized cartilaginous species.

Presented by Sir E. Home, Bart.

2. *In Reptiles.*

1312. The brain of a Turtle (*Chelonia Mydas*, BROGN.). The dura mater with one half of the arachnoid membrane have been removed, and the vessels of the pia mater minutely injected. The partial removal of the arachnoid shows how loosely it envelopes the brain, and at the same time displays the form and disposition of the cerebral organs. The hemispheres of the cerebrum exhibit a higher development than in the preceding class, and are the largest of the encephalic masses; but their structure is extremely simple, and their surface smooth. The olfactory nerves, by which the specimen is suspended, are continued from the anterior and inferior part of the hemispheres, and are bulbous at their commencement; they are formed by three roots, of which the inferior ones are the most distinct. The optic lobes, or bigeminal bodies, are two spherical bodies, as in fishes, not divided into four by a transverse fissure as in mammals. They are on a plane inferior to the cerebrum and cerebellum, but occupy a space between these parts uncovered by either. The optic nerves form a swelling at their commissure, beyond which they are continued for a short distance parallel to one another. A bristle is inserted into the infundibulum behind the commissure. In the angle between the hemispheres and optic lobes the pineal gland is continued upwards; it is hollow, and a bristle is placed in its cavity, which communicates with the fourth ventricle. The cerebellum is of an elongated form, without lateral lobes, and presents a simple and smooth exterior. It extends over the anterior part only of the fourth ventricle, which is consequently left uncovered posteriorly, except by membrane: a bristle is placed in that cavity. The medulla oblongata is without a pons Varolii. The origins of the several cerebral nerves are shown, and the sixth, eighth, and ninth pairs are distinguished by dark threads being tied round them. The origin of the nervus accessorius and its recurrent course to join the nervus vagus are very clearly displayed.

1313. The brain of a large Turtle (*Chelonia Mydas*, Brogn.). The dura mater is removed and the arachnoid reflected from the right side, showing its extensive development and the loose cellular structure by which the space left between the brain and the walls of the cranial cavity is occupied. The arachnoid is firmly fixed below by two ligaments, which converge from the sides of the spinal chord to be attached to a cartilaginous tubercle situated on the basilar process of the os occipitis. A number of filamentary processes pass from the space between the cerebral and optic lobes to the expanded layer of the arachnoid above, and are attached to the pia mater, representing a rudimentary falx. The roof of the fourth ventricle consists posteriorly of pia mater alone, which there forms a transparent sac: anteriorly it is covered by the medullary substance of the dilated cerebellum, which is only a line in thickness, and is smooth externally as in the osseous fishes. The optic lobes are left entire, showing the plexus of vessels on their exterior. The whole of the elongated pyriform pineal gland is seen. The cerebral hemisphere is laid open, showing the thinness of the medullary layer which covers the corpus striatum and forms the roof of the lateral ventricle. The origins of all the cerebral nerves are shown. The third and fourth are separated by the crus cerebri, which from the small size of the brain is of little width. The nervus accessorius may also be observed arising from the posterior tract as far down as the third pair of cervical nerves.

1314. The brain of a Turtle, with the dura mater and arachnoid removed, and the cavities or ventricles of the cerebellum, bigeminal bodies, and cerebral hemispheres laid open. The following is Mr. Hunter's description of this preparation: "In the first or superior ventricle is an eminence which extends a little way into the olfactory nerve, and runs through the whole length of the ventricle. The plexus choroides is also seen in the ventricle. The ventricle of the nates is exposed, and a white bristle is placed in it; as is the ventricle of the cerebellum with a black bristle lying in it. At the lower part of the ventricle is a continuation of the tunica arachnoides, which shuts up or makes part of the ventricle. In the angle or quadrangle made by the cerebrum and nates, &c. is a duct or canal like the infundibulum leading from the upper part of the skull to the last ventricle."

The canal here described is the cavity of the body which occupies the place of the pineal gland, and which is shown entire in the preceding specimen. The bodies termed nates by Mr. Hunter are regarded by Cuvier as the optic thalami (see *Leçons d'Anat. Comp.*, tom. ii. p. 164); but since the publication of the works of Arsaki*, Serres†, and Desmoulins‡, their analogy to the bigeminal bodies or optic lobes of Mammalia has been generally admitted.

1315. A longitudinal section of the head of a young Crocodile, showing the expansion of the spinal chord into the medulla oblongata, its continuation into the cerebral lobe, and the superposition of the cerebellum, optic lobes, and cerebral hemispheres, with the ventricular cavities in the cerebellum and optic lobe. The pineal gland above the crus cerebri, and the pituitary gland below, are also shown; together with the olfactory bulb, which is continued beyond the cerebral hemisphere, and connected therewith by an intervening pedicle.

1316. The opposite section of the same head, in which the cavity in the cerebral hemisphere, and the convex body projecting from its anterior wall, representing the corpus striatum, are exposed. A similar body projects from the posterior wall of the ventricle of the optic lobe.

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* *De Cerebro et Medulla Spinali Piscium*, 1813.

† *Sur le Système Nerveux*, 1824.

‡ *Anatomie des Systèmes Nerveux des Animaux à Vertèbres*, liv. ii. tom. i. p. 140.

The cranial cavity is here seen to be accurately moulded to, and completely filled by the brain; but it must be borne in mind that the preparation exhibits a condition of parts probably peculiar to the fœtus or recently excluded young.

1317. The brain, divested of its membranes, of a young Crocodile. The original description states that the brain is, "to appearance, made up of five parts; two anterior, answering to the cerebrum; two behind these, which answer to the 'nates and testes'; the posterior, the cerebellum;" to which may be added a sixth part, viz. the medulla oblongata.

1318. "The brain of a Crocodile six feet long*, the body thicker than a man's thigh." It measures only an inch and a half in length, and does not equal an inch in diameter at the broadest part, although the magnifying effect of the glass and spirit gives it the appearance of having greater breadth. The cerebellum, optic lobe, and hemisphere are laid open on the left side to show that they are hollow, as in the *Chelonia.* The chief difference between this brain and that of the Turtle obtains in the large size of the optic lobe and cerebrum as compared with the cerebellum, in the more pyriform figure of the cerebral hemispheres, and in the transverse fissure of the cerebellum.

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* This, in all probability, is the Crocodile alluded to in the following passage from a Hunterian MS. obtained from the executors of Sir Everard Home, and entitled 'Modern History of the Absorbing System.'

"In the beginning of the winter 1764–5 I got a Crocodile which had been in a show for several years in London before it died. It was at the time of its death perhaps the largest ever seen in this country, having grown to my knowledge above three feet in length, and was above five feet long when it died. I sent to Mr. Hewson; and before I opened it, I read over to him my former descriptions of the dissections of this animal relative to the 'Absorbing System,' both of some of the larger lymphatics and of the lacteals, with a view to see how far these descriptions would agree with the appearances in the animal now before us, and on comparing them they exactly corresponded. This was the Crocodile from which Mr. Hewson took his observations of the colour of the chyle. See *Phil. Trans.* 1769, p. 199.

"The intention of my showing this Crocodile and also reading my former dissections to Mr. Hewson was that he might see that I had a tolerable description of this system in the *Amphibia,* and to convince him that this description must have been written some considerable time before, in all probability before my going abroad; as Crocodiles are seldom to be had in this country, and I could hardly have dissected two Crocodiles besides this between May 1763, (the time I returned from Portugal,) or the autumn 1763, when the Turtle was dissected, and the beginning of the winter 1764–5. Mr. Hewson at the time appeared satisfied, or at least made no remarks."

3. *In Birds.*

1319. The brain and spinal chord of the embryo of a Goose at about the twelfth day of incubation. This has been prepared and placed at the commencement of the present subseries to show the analogy which the brain of the bird at this early period bears in the form, proportion, and relative position of the several masses, to that of the inferior classes in the preceding subseries.

The optic lobes now equal in size and occupy a situation immediately posterior to the hemispheres; their division into two lateral portions by a mesial fissure has just begun to appear. The cerebellum is a thin film of medullary matter extending transversely above the fourth ventricle, and almost concealed by the superincumbent optic lobes. The wide fissure between the lateral columns of the spinal chord, and the equable diameter of the chord, in correspondence with the rudimentary condition of the extremities, may be observed.

1320. The brain of a Goose (*Anser palustris*, Brisson). The pia mater is minutely injected, and bristles are placed at the origins of all the cerebral nerves of the left side. The brain presents the same masses as in the cold-blooded Ovipara, but the cerebellum, though still defective in the lateral lobes, is increased by transverse convolutions, and extends forwards to touch the cerebrum. The optic lobes therefore, instead of being superior, as in the embryo state and in the Reptile, are pushed aside, and appear below in the interspace between the crura of the cerebellum and cerebrum. The cerebral hemispheres have acquired a greater magnitude than in the preceding classes, but are still smooth exteriorly and devoid of convolutions: they resemble those of the Crocodile in their pyriform figure and in the continuation of the small olfactory nerves from their anterior apices. As there are no lateral lobes of the cerebellum, so there is no connecting commissure or pons Varolii of the medulla oblongata, and the eminences termed corpora pyramidalia and corpora olivaria are also wanting.

1321. The brain of a Goose, with the cerebellum slit down longitudinally, showing the fourth ventricle continued into its crura, and the processes of white and grey matter forming the arbor vitæ. The left optic lobe is laid open, showing that it is hollow, as in Reptiles, and a bristle is passed from it to the fourth or cerebellic ventricle with which it is continuous. The ventricle of the right cerebral hemisphere is also exposed, showing how great a proportion of the mass is formed by the corpus striatum within, and how thin is the external medullary covering. The lateral ventricle is continued forward to the olfactory nerve.

1322. The brain of an Ostrich (*Struthio Camelus*, LINN.) minutely injected. Both lateral ventricles are exposed, and the plexus choroides is shown. The right optic ventricle is laid open, and the section at the same time displays the proportion of grey and white matter of the lobe itself. A transverse section has been removed from the cerebellum, showing its transverse folds and the apex of its ventricle. A black bristle is placed in the cavity of the olfactory nerve, which is continuous with the lateral ventricle, and a white one is inserted into the infundibulum. The other cerebral nerves are also indicated by portions of bristle. The arteries forming the circle of Willis are well displayed.

1323. The section of the cerebellum removed from the preceding brain.

4. *In Mammals.*

1323 A. The brain of a young Kangaroo about three weeks after uterine birth, showing that the encephalic masses in the Mammalia correspond in number, relative position, and size with those of the oviparous classes at an early period of the development of the brain. The optic lobes, or *corpora quadrigemina*, e. g., are almost as large as the cerebral hemispheres, are quite uncovered by and situated behind them; and they are not divided by a transverse fissure.

The hemispheres are smooth, pyramidal, and pointed anteriorly, as in the Crocodile. The cerebellum is a small film covered by the optic lobes, as in the embryo of the Bird. The pons Varolii is not yet developed upon the medulla oblongata. *Prepared by Mr. Owen.*

1323 B. The brain of an Opossum (*Didelphis Virginiana*, LINN.). In this species the cerebellum, optic lobes, and cerebral hemispheres retain throughout life almost the same relative positions as in Reptilia, the cerebrum and cerebellum not being developed so as wholly to conceal the optic lobes, which consequently appear as the second masses of the brain. The hemispheres present a single shallow anfractuosity anteriorly, but have a smooth unbroken surface in the remainder of their extent, as in the oviparous Vertebrata. The olfactory nerves are continued from the inferior surface of the hemispheres, and are separated from them by a fissure. They are of very large size, appearing as a continuation of the basis of the brain itself. The hemispheres are separated to show the absence of a corpus callosum and septum lucidum, but they are united by the fornix, which is wanting in the preceding classes.

With these resemblances to the oviparous type of structure we perceive, however, in the present specimen, a structure characteristic of the brain of the Mammalia, viz. the division of the optic lobes by a transverse fissure into four tubercles, whence they have been denominated *tubercula quadrigemina*, or more correctly *bigemina*. In human anatomy the anterior tubercles are termed 'nates', the posterior ones 'testes': in the present instance the testes have the greatest transverse diameter, but the nates have the greatest longitudinal diameter. The cerebellum equally recedes from that of Birds and Reptiles in the large development of the lateral lobes, which are connected by the commissure termed pons Varolii or tuber annulare. Behind the pons a longitudinal fissure may be observed extending on either side the mesial fissure of the medulla oblongata: the tracts included by these fissures are the corpora pyramidalia, which, like the pons, the lateral lobes of the cerebellum, the transverse division of the optic lobes, and the fornix, are rudimental or wanting in the brains of Birds and cold-blooded Vertebrata. *Prepared by Mr. Owen.*

1323 C. A longitudinal section of the brain of a Dasyure (*Dasyurus Maugei*, GEOFF.). This shows the extent to which the optic lobes are covered by the cerebrum and cerebellum. A portion of mica is placed in the lateral ventricle above the fornix, separating the lateral hemispheres, and showing the absence of the corpus callosum. Black bristles are placed in the anterior and soft commissures. The optic lobes are without ventricles, or rather their cavity is reduced to the channel termed 'iter a tertio ad quartum ventriculum'. *Prepared by Mr. Owen.*

1323 D. A longitudinal section of the brain of a Hedgehog (*Erinaceus Europæus*, LINN.). In which the small corpus callosum is seen above the mica, which is placed in the same situation as in the preceding specimen. The hemisphere is small, and devoid of convolutions.

1323 E. The brain of a Beaver (*Castor Fiber*, LINN.). This is prepared to illustrate Mr. Hunter's observation in the Introduction to the present series, that the brain of the Beaver is devoid of convolutions.

In this respect it resembles the brain of most of the Marsupial, Rodent, Edentate, Cheiropterous and Insectivorous Mammals, but the cerebral hemispheres are developed so as to extend to the cerebellum and conceal the optic lobes. The pituitary gland, the origins of the olfactory nerves, the decussation of the optic nerves, and the different parts observable on the under surface of the medulla oblongata are also shown.

Prepared by Mr. Owen.

1323 F. A longitudinal section of the brain of a Squirrel (*Sciurus vulgaris*, LINN.), showing the complete covering of the optic lobes by the increased development of the cerebral and cerebellic masses. The corpus callosum is also here seen of greater extent; but the hemispheres in this as most of the small Rodentia are devoid of convolutions.

Prepared by Mr. Owen.

1323 G. The brain of an Agouti (*Dasyprocta Agouti*, ILLIG.). In this Rodent the surface of each hemisphere is increased by a single longitudinal convolution, which runs parallel with the mesial fissure. The cerebellum is slightly separated from the cerebrum to show the large size of the bigeminal bodies or optic lobes as compared with the higher Mammalia.

Prepared by Mr. Owen.

1324. The brain of a Tiger (*Felis Tigris*, LINN.). The pia mater has been removed from the medulla oblongata, showing the transverse tract of medullary matter posterior to the tuber annulare, called *corpus trapezoideum*; this is traversed by the corpora pyramidalia. The development of the cerebrum is such as not only to cover the optic lobes or bigeminal bodies, but also the anterior half of the cerebellum itself; and the surface of the cerebrum is augmented by convolutions, of which one is analogous to the single convolution in the Agouti, and extends parallel with the fissure dividing the hemispheres; a second runs parallel with and external to the preceding: a transverse one proceeding from the mesial fissure marks off what may be regarded as the anterior lobes, which, together with the lateral regions of the hemispheres, are traversed by other anfractuosities.

1325. The brain of a Lion (*Felis Leo,* LINN.). This closely resembles the preceding in general form and disposition of the convolutions.

1326. The brain and part of the spinal chord of a young Lion, with the vessels of the pia mater minutely injected. The left lateral ventricle is exposed, showing the pes hippocampi and the choroid plexus. The fourth ventricle is also laid open, and contains a similar plexus of minute arteries. Bristles are inserted into the hollow olfactory and the optic nerves, and black threads are tied round the origins of the remaining cerebral nerves of the right side. A small quill is placed in the infundibulum; but the pituitary gland, which may be seen in both the preceding specimens, is here removed. The union of the vertebral arteries to form the basilar artery, the great length of that vessel, and its division to join with the internal carotids in the formation of the circle of Willis, are well displayed.

1326 A. A portion of the basis of the brain of a Lion, prepared to show the form and relative proportions of the bigeminal bodies or optic tubercles; of these, the posterior, though smaller in longitudinal diameter, are broader and rise above the level of the anterior pair. *Prepared by Mr. Owen.*

1326 B. A similar dissection of the brain of a Ruminant animal, showing the posterior bodies or testes, of equal size with the preceding, but the anterior ones or nates of nearly double the size of those of the carnivorous animal. The size of the entire brain was alike in both specimens.

Prepared by Mr. Owen.

1327. The brain of a Sheep injected. This displays a greater number of convolutions than in the Carnivora, and they converge from behind forwards towards the hemispheric fissure instead of running parallel therewith.

The olfactory nerves, as in the Carnivora, are hollow, and rise principally from the prominent inferior apex of the hemisphere. The other cerebral nerves are indicated by black bristles.

1328. The brain of an Ox (*Bos Taurus*, Linn.) injected, and the pia mater removed from the left hemisphere to show the convolutions, which are more numerous and wavy than in the sheep.

1329. The brain of a Horse (*Equus Caballus*, Linn.). The convolutions are still more numerous and complicated in this species than in the preceding. The following is the original description of this specimen: "Brain of a Horse; which is oblong, in which the anterior and middle lobes are not so well marked as the human; the medulla oblongata is more in the direction of the whole brain, and therefore the whole under surface is flattened; the cerebellum is not so immediately under the posterior lobes, but projects further back, which is owing to the direction of the medulla spinalis. The olfactory nerves are very large, especially at their insertion, and are hollow, which cavity is a continuation of the lateral ventricle."

1330. The brain of an Ass (*Equus Asinus*, Linn.), in which a section has been removed from the left hemisphere, exposing the protuberance in the inferior horn of the lateral ventricle termed 'hippocampus major'; also the 'corpus fimbriatum', a part of the corpus striatum, the fornix, and the medullary lamina, or septum lucidum, connecting the fornix with the great commissure above, or 'corpus callosum': all these parts are peculiar to the brains in Mammalia, but not common to all of the class. A portion of the left lobe of the cerebellum has also been taken away, showing the ramifications of the crus cerebelli, and the granular substance which closes the fourth ventricle posteriorly.

1331. The brain of a young Elephant (*Elephas Asiaticus*). The absolute size of the organ in this species exceeds that of man. But the proportion which the cerebrum bears to the rest of the brain, and especially that part of the hemisphere which forms the roof and sides of the lateral ventricle, is much less.

The hemispheres are broad and short, with a considerable development of the natiform protuberance. The convolutions are comparatively small and numerous. A lateral section has been removed from the left hemisphere, which shows that the anfractuosities are also deep, extending in some cases more than two thirds of an inch into the substance of the brain. The hippocampus is comparatively smaller than in the Ass, and the corpus striatum larger. The ventricle is seen to be continued into the olfactory bulb. The cerebellum is of considerable width, and its surface, as shown by the lateral section, is increased by numerous and complex anfractuosities. The tuber annulare corresponds in size to the development of the lateral lobes of the cerebellum. The corpora olivaria are remarkably prominent.

The origins of all the cerebral nerves are shown, among which the olfactory nerves and the fifth pair, which supplies the proboscis, are remarkable for their prodigious size; whilst the optic nerves, and those which supply the muscles of the eye, are as remarkable for their small size. The pia mater is left on with the vessels at the base of the brain. A bristle is placed in the infundibulum.

1332. The brain, with part of the spinal chord, of a young Porpesse, soon after death (*Phocæna communis,* Cuvier), minutely injected. This brain resembles that of the Elephant in the great lateral development of the cerebrum and cerebellum, but they are relatively larger in proportion to the spinal chord, and the cerebral convolutions are much more numerous. These are also seen to be of considerable depth in the section of the left hemisphere. In the ventricle, which is laid open on the side, is seen the plexus choroides, which is of a peculiar structure, being transversely folded like the branchiæ of a bivalve.

Black threads are tied round the cerebral nerves, of which the optic are in this species the first pair, the olfactory nerves being wholly deficient. The thick membranes of the spinal chord are laid open to show the organs of the cervical nerves, which, from the shortness of the neck of the Porpesse, rise close together.

1333. The entire brain of a fullgrown Porpesse, showing its remarkable size and form, and the absence of the olfactory nerves.

1334. The plexus choroides of the Porpesse, showing the close-set transverse folds of the membrane upon which the vessels are distributed.

1335. A portion of the brain of a Piked Whale (*Balæna Boops*, LINN.), 'showing a fibrous texture'.

1336. A similar specimen.

1337. The *plexus choroides* of the same Whale, showing the union of the two plexuses, and the delicately plicated and fimbriated membrane upon which the vessels ramify.

"The size of the brain differs much in the different genera of the Whale-tribe, and likewise in the different proportion it bears to the bulk of the animal. In the Porpesse, I believe, it is largest, and perhaps in that respect comes nearest to the Human.

"The size of the cerebellum in proportion to that of the cerebrum is smaller in the Human subject than in any animal with which I am acquainted. In many quadrupeds, as the Horse, Cow, &c., the disproportion in size between cerebellum and cerebrum is not great, and in this tribe it is still less, yet not so small as in the bird, &c.

"The whole brain in this tribe is compact, the anterior part of the cerebrum not projecting so far forwards as in either the Quadruped or in the Human subject; neither is the medulla oblongata so prominent, but flat, lying in a kind of hollow made by the two lobes of the cerebellum.

"The brain is composed of cortical and medullary substances, very distinctly marked; the cortical being, in colour, like the tubular substance of a kidney; the medullary, very white. These substances are nearly in the same proportion as in the Human brain. The two lateral ventricles are large, and in those that have olfactory nerves are not continued into them as in many Quadrupeds; nor do they wind so much outwards as in the Human subject, but pass close round the posterior ends of the thalami nervorum opticorum. The thalami themselves are large; the corpora striata small; the crura of the fornix are continued along the windings of the ventricles, much as in the Human subject. The plexus choroides is attached to a strong membrane, which covers the thalami nervorum opticorum, and passes through the whole course of the ventricle much as in the Human subject.

"The substance of the brain is more visibly fibrous than I ever saw it in any other animal, the fibres passing from the ventricles, as from a centre, to the circumference, which fibrous texture is also continued through the cortical substance. The whole brain in the Piked Whale weighed four pounds ten ounces.

"The nerves going out from the brain, I believe, are similar to those of the Quadruped, except in the want of the olfactory nerves in the genus of the Porpoise." *Hunter, on Whales, Phil. Trans.* 1787, p. 423.

1338. The brain of a Baboon (*Papio Mormon*, Cuv.). The cerebral hemispheres are of greater proportionate size than in any of the preceding specimens, and they are developed so far backwards as to cover the cerebellum. The posterior lobes exhibit anfractuosities characteristic of the brain in the higher Simiæ, as the Baboons and Orangs.

1338 a. The brain of a Chimpanzee (*Simia Troglodytes*, Linn.). This brain, in the relative proportions of the different parts and the disposition of the convolutions, especially those of the posterior lobes, approaches nearest to the Human brain. It differs chiefly in the flatness of the hemispheres, in the comparative shortness of the posterior, and in the narrowness of the anterior lobes. *Presented by W. E. Leach, M.D. F.L.S.*

1339. The brain of a Human Female, covered by the vascular and serous investing membranes. Here the cerebral hemispheres extend backwards beyond the cerebellum, and their magnitude as compared with that part, and especially with the nerves given off from the brain, and with the spinal chord, far exceeds that of any other animal. The weight of this brain is two pounds two ounces.

1340. The medulla oblongata of the Human subject, with the membranes carefully removed to show the fibrous texture of the different parts, and the direction of the superficial layer of fibres.

1341. A similar preparation, showing the decussation of the anterior pyramids, and also a variety in the course of some transverse fibres which cross over the surface of the corpora olivaria and pyramidalia.

B. *MEMBRANES OF THE BRAIN.*

5. *Pia Mater.*

"The brain in all animals is covered by a membrane or membranes; but these differ very much in different orders of animals. In the inferior classes, such as the Snail and Insects, the brain is covered by a strong white coat. In the higher classes the brain is inclosed in a pretty solid cavity, and there we find the immediate covering of the brain to be a very thin transparent membrane.

"This membrane would appear to answer two purposes in the œconomy of the brain in some animals, while it would seem to have only one office in others.

"In the first it would appear to serve as a smooth external covering for any motion that the brain might have upon the dura mater, and also to attach itself to the dura mater in some parts to confine that motion*. Its internal surface is much more irregular, answering to all the inequalities of the external surface of the brain; so that every part of the surface of the brain might be covered by this membrane. The inequalities are more in those animals which have large brains.

"The second use for the pia mater would appear to be a conductor of the blood-vessels to and from the substance of the brain. The larger vessels ramify upon it and divide into the smaller, and then these dip into the substance itself." *Hunterian manuscript Catalogue.*

1342. A portion of the vascular covering, or pia mater, of the brain of a Goose (*Anser palustris*, Brisson). The internal surface of the membrane is smooth and equable like the external, corresponding to the smooth unconvoluted surface of the brain which it invests. The vessels are injected, showing their ramifications upon the membrane.

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* These properties should be referred to the reflected layer of the arachnoid membrane, of which Mr. Hunter seems here to be speaking.

1343. A portion of the pia mater, with the arachnoid or serous membrane adhering to it, from one of the cerebral hemispheres of the Human brain. The pia mater sends off from its inner surface a series of duplicatures which pass between the convolutions of the brain, and support the vessels in their progress to the deeper surfaces. The villous character of the membrane is produced by the minute and empty vessels, which, adhering to the pia mater, have been torn from the cerebral substance. The arachnoid membrane is extended smoothly over the external surface of the pia mater, without being continued with it into the anfractuosities of the hemispheres. Another layer of arachnoid membrane is reflected over the opposite surface of the dura mater, and the serous exhalation between the two layers lubricates them and facilitates the motions of the brain upon the skull and dura mater. These motions are of two kinds, one synchronous with the pulse, the other with the actions of respiration.

6. *Dura Mater.*

"This membrane is not to be found in all animals, but only in those whose brains are inclosed in bones: those animals whose brains are inclosed in cartilages can hardly be said to have this membrane, such as some Fishes: in other animals whose brains are inclosed in soft parts, as Snails, the brain has no such covering*: therefore, how far this membrane is to be considered as a covering for the brain, or as a lining for the bone, is not clear; for all bones have coverings of this kind, and therefore it may be considered merely as a covering to those parts. But as it is here much thicker, and sends in folds for visibly other purposes than a lining for the skull, it may with propriety be considered as answering both purposes. In brains that are large we find it insinuating itself between the different divisions by folds called 'processes', most probably for the better support of this viscus, and in order to lessen lateral pressure inwards, especially where, from the projection of the head, it must have considerable motion." *Hunterian manuscript Catalogue.*

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* The strong white coat which Mr. Hunter speaks of as investing the brain of the Snail, &c. is regarded by Cuvier as analogous to the dura mater.

1344. The dura mater, or fibrous covering of the brain, and the adherent layer of arachnoid membrane, removed from the superior surface of the hemispheres of the Human Brain. From the middle of the inner surface is continued the 'falciform process', which separates the two hemispheres. The termination of the longitudinal venous sinus, and the commencement of the two lateral sinuses are shown at the posterior part of the falx. A bristle is inserted into a vein of the dura mater. The arteries of the dura mater are seen filled with injection.

1345. A portion of the upper part of the Human dura mater, showing the course of its glistening fibres, with the longitudinal sinus laid open to show the 'glandulæ Pacchioni.' The two layers of membrane composing the dura mater have been separated, and a portion of the exterior layer is removed from one side.

1346. A portion of the dura mater of an Elephant (*Elephas Asiaticus*, BLUM.), showing the termination of the falx, and the commencement of the tentorium or process which separates the cerebrum from the cerebellum. The two fibrous layers of the dura mater are separated by a softer cellular substance in which the vessels ramify. It may be observed that the thickness of the dura mater is in proportion to the size of the skull and of the entire animal, but not to the size of the brain, which does not much exceed that of the Human brain.

1346 A. A portion of the cranium of a Dog (*Canis familiaris*, var. *Borealis*), showing the processes of the dura mater called the 'falx' and 'tentorium'. A portion of the dura mater is reflected from the latter part, showing the bony plate which is extended between the layers of the fibrous membrane of the tentorium. This structure obtains in most of the Carnivora. *Prepared by Mr. Owen.*

C. *STRUCTURE OF THE SPINAL CHORD.*

" *Of the Medulla Spinalis.*

" The Medulla Spinalis is not common to all animals that have brains, but would appear to be peculiar to those only which have extensive external parts, or such as are far removed from the brain. It is joined with the heart when that viscus becomes a little complicated, viz. when of two cavities.

" It is evidently a continuation of the substance of the brain, and principally of its medullary substance; and as all that part of the brain which gives off nerves is medullary, for the same reason the medulla spinalis is obliged to be medullary externally, as it is giving off nerves throughout its whole length.

" It is pulpy in its consistence, although not so much so as the brain: it would appear to be contained in cells, or that there is a tender network of fibres interwoven, although it is a substance somewhat firmer in consistence than the brain itself.

" Although it is a continuation of the brain, and seems to answer the same purpose, yet it does not keep the same proportions with respect to size of brain, and size and kind of animal. It rather bears a kind of inverse proportion. In the most perfect animals it is in general smallest in proportion to the size of the animal; in them too it is rather smallest where the brain is largest; so far it is taking on a circumstance belonging to the nerves.

" The medulla must have considerable influence upon the nerves somewhat independent of the brain, or else they might all have arisen from the brain itself: what strengthens this idea is the circumstance of the medulla being always thicker at those parts where it gives off the largest nerves, such as in the neck for the upper extremity, and in the loins for the lower.

" The medulla varies less than the brain. It may be divided into two kinds: the first is that belonging to the less perfect classes of" [vertebrate] " animals, and the second obtains in the most perfect class. The principle upon which this division is made is the difference in the termination of the medulla spinalis. In the first it is continued with the vertebræ to the end of the tail (in those animals which have one); in the second, or those of the more perfect class, it terminates in the loins.

" As the medullary substance in this class, therefore, ends in the loins, before the going out of the nerves to the lower extremities, the nerves are obliged to rise higher in the back than they otherwise might do. These nerves are still obliged to go on in the course of the spine to pass out of the lateral holes; arising similar to the hairs of a horse's tail from the tail itself, whence they have been called *cauda equina.*

" The second class of medullæ spinales I shall divide into two kinds; the first of which is where the nerves of the cauda equina are inclosed in the dura mater in their passage towards the outlets, and the second is where they pass immediately through the covering or dura mater, and afterwards pass down to their respective outlets. To this division might be added a third, viz. where the cauda equina in some degree partakes of both. Of the first kind we have examples in the Human Subject, the Monkey; of the second, in the Porpesse; and the mixed occurs in the Elephant, the Lion, and perhaps most quadrupeds.

" In our first division, the medulla, in the more imperfect animals, is continued into the sacrum, and even into the tail, becoming pretty regularly smaller and smaller. This regular diminution of size is owing most probably to some of these animals having no extremities, as in Fish, and to their being but very small in others, as in some of the Amphibia, and the tail being thick at its origin; so that the parts that are to be supplied with nerves are pretty uniformly the same, and therefore the medulla gives off nerves through its whole course, which go out of the holes in the spine almost immediately: however, it may be observed that they pass more obliquely downwards near the tail than nearer to the neck or head.

" In the Fowl the medulla is continued on to the tail, and gives off the nerves as above described; but it undergoes a swelling in the loins, where the nerves of the legs arise, and also a swelling where the nerves of the wings are given off." *Hunterian manuscript Catalogue.*

7. *In Fishes.*

1347. A section of the head and vertebral column of a Skate (*Raia Batis*, Linn.), in which the whole of the cerebro-spinal axis of the nervous system is laid bare by the removal of the posterior parietes of the cranial and spinal cavities. The medulla spinalis is continued, regularly decreasing in size, to the caudal end of the vertebral column, giving off the nerves in pairs very close together. Those which supply the great pectoral fins may be seen converging as they pass outwards: below these the nerves pass obliquely backwards to the interspaces of the vertebræ, by which they escape, and their course is longer and more oblique in the vertebral canal in proportion as they come off nearer to the termination of the chord.

The parts have been finely injected.

1347 a. A section of the vertebral column, with the spinal chord and its membranes, of the Basking Shark (*Selache maxima*, Cuvier). The canal of the spinal column is lined with a thin fibrous membrane, which closely adheres to the cartilage, and must be regarded as analogous to a dura mater. The contained chord is much smaller than the canal, and the interspace is filled up with a loose cellular arachnoid tissue and a network of large vessels. The parts have been injected.

Prepared by Mr. Clift.

1347 b. A portion of the spinal chord of the same Shark.

Prepared by Mr. Clift.

8. *In Reptiles.*

1348. A section of the anterior part of a young Crocodile, with the cranium and vertebral canal laid open, exposing the brain and commencement of the spinal chord. These parts are here seen to be invested by a strong fibrous external membrane or dura mater, which is partly removed. The more immediately investing vascular membrane is injected.

The brain is preserved, to show its small size in proportion to the medulla spinalis. The convex membrana tympani and its ossiculum, or columella, extending across the tympanic cavity, are exposed on the right side.

1349. "The medulla spinalis of a Crocodile. In this animal, as in the Fish, there is little variety;" i. e. the spinal chord gradually decreases towards the tail, without manifesting those partial enlargements which characterize the chord in animals that have well-developed extremities, requiring a large supply of nervous energy.

1350. A section of the spinal chord of a Turtle (*Chelonia Mydas,* Brongn.), showing its uniform diameter, the distances at which the nerves are given off, and its close investment by the dura mater.

1351. The medulla spinalis apparently of some large Reptile, showing the gradual diminution of the chord to its caudal extremity.

9. *In Birds.*

1352. A section of the cervical portion of the spinal chord of an Ostrich (*Struthio Camelus,* Linn.). The thick dura mater is turned down from its anterior surface, showing the double roots of a pair of the spinal nerves, just above the line of reflection: all the membranes are stripped off from the posterior or dorsal surface, showing the deep longitudinal fissure at that part.

1353. A smaller section from the same region of the spinal chord. The dura mater is removed, together with one of the posterior columns of the chord, showing the depth of the posterior fissure. A bristle is passed through the fissure above this part, showing the canal, which is continued from the fourth ventricle down the spinal chord. The origins of a pair of cervical nerves are carefully displayed. The posterior roots are nine or ten in number, arising from an extended surface: the anterior roots, on the contrary, are only three or four in number, and the site of their origin is proportionally small. The large ganglions formed on the posterior roots are preserved.

1354. A section of the dorsal portion of the spinal chord of an Ostrich, with its membranes partially removed.

1355. The sacral and caudal portions of the spinal chord of an Ostrich, showing the enlargement which takes place at the origins of the nerves of the posterior extremities, and the lateral separation of the posterior columns at that part, leaving the interspace which is termed the ventricle of the chord, or the 'sinus rhomboidalis'. The following is the original description of this preparation :—" The part of the medulla which lies in the loins and tail of an Ostrich. That part which lies in the loins is considerably larger than those which belonged to the neck and back ; and then it becomes pretty fast smaller to the tail. This swelling in the loins is owing, perhaps, to this bird having such large thighs and legs ; and when we consider that this bird, having such small wings, must have the whole progressive motion performed by the legs, and the legs are therefore longer in proportion to the size of the bird than in birds in common, we must see why the medulla ought to be large at this part in this bird."

1356. A portion of the sacral swelling and caudal prolongation of the spinal chord of an Ostrich, with the membranes reflected, showing the origins of some of the sacral nerves on the anterior surface, and the longitudinal fissure continued down the opposite side.

1357. The attenuated caudal prolongation of the spinal chord of an Ostrich.

1358. The brain and spinal chord of a Partridge (*Perdix rufa,* Linn.) *in situ,* exposed by the removal of the posterior parietes of the vertebral column, showing the brachial and sacral enlargements of the chord, and the ventricle in the latter.

10. *In Mammals.*

1359. The cerebellum and spinal chord of a Porpesse (*Phocæna communis,* Cuv.).

"The dura mater is removed from about one half of the breadth of the posterior surface, through its whole length, to expose the medulla. It is not so loose as in the Human subject, but incloses the medulla very tightly. It goes no further than to the lower end of the medullary substance ; so that it does not inclose the cauda equina beyond that termination, as in the Human subject or Monkey. The nerves go out of this sheath immediately, through the whole length of the medulla ; so there is no cauda equina on the inside of the dura mater, either above or below the termination of the medullary substance. The cauda equina is therefore on the outside of the sheath of the dura mater. It is not so large as in any of those [mammals] which have four extremities, the hind legs in these requiring a considerable number of nerves which the Porpesse has no occasion for."

The cervical enlargement of the medulla, and the close aggregation of the spinal nerves, in correspondence with the shortness of the neck in this aquatic species, is worthy of notice, as also the angle at which the nerves leave the spinal chord. The first dorsal nerves pass directly outwards, the succeeding nerves are inclined more and more obliquely backwards, until they are extended in the axis of the chord to form the cauda equina. The two roots of each nerve are longer before they unite in proportion as their course is more oblique. The ganglions on the posterior roots are distinctly shown.

1360. The spinal medulla, or chord of a Porpesse, injected. The dura mater has been removed from the posterior surface, showing the origins of the posterior roots of the spinal nerves, and the close investment which the membrane forms for the chord.

1361. The cervical portion of the spinal chord of a Dolphin (*Delphinus Tursio*, Fabr.), showing the origins of the eight cervical and first dorsal pairs of nerves. The dura mater has been removed from the anterior surface, and split down and reflected from the posterior surface of the chord : upon the latter the arachnoid membrane has been preserved entire, and a white bristle is placed behind it. The posterior fasciculi are the largest where they rise from the substance of the medulla ; the anterior ones come off more irregularly, and unite into separate fasciculi.

1362. A transverse section of the dorsal portion of the spinal chord of the same Dolphin, including the double origins of one pair of nerves, and showing the central canal and the three membranes of the spinal chord.

1363. A section of the spinal chord of the Piked Whale (*Balæna Boops*, Linn.), showing the double origins of the nerves.

1364. The termination of the spinal chord of the same Whale, from the posterior surface of which one half of the thick dura mater has been removed, showing that it forms the same close investment for the chord as in the Porpesse, and that the long, separated roots of the terminal nerves, composing the cauda equina, are exterior to the sheath of the dura mater.

"The medulla spinalis is much smaller, in proportion to the size of the body, than in the human species, but still bears some proportion to the quantity of brain ; for in the Porpesse, where the brain is largest, the medulla spinalis is largest ; yet this did not hold good in the Spermaceti Whale, the size of the medulla spinalis appearing to be proportionally larger than the brain, which was small when compared to the size of the animal. It has a cortical part in the centre, and terminates about the twenty-fifth vertebra, beyond which is the cauda equina, the dura mater going no lower. The nerves which go off from the medulla spinalis are more uniform in size than in the quadruped, there being no such inequality of parts, nor any extremities to be supplied, except the fins.

"The medulla spinalis is more fibrous in its structure than in other animals ; and when an attempt is made to break it longitudinally, it tears with a fibrous appearance, but transversely it breaks irregularly.

"The dura mater lines the skull, and forms in some three processes, answerable to the divisions of the brain, as in the human subject ; but in others, this is bone. Where it covers the medulla spinalis, it differs from all the quadrupeds I am acquainted with, inclosing the medulla closely, and the nerves immediately passing out through it at the lower part, as they do at the upper, so that the cauda equina, as it forms, is on the outside of the dura mater." *Hunter, on Whales, Phil. Trans.* 1787, p. 424.

1365. "The lower part of the medulla spinalis of a Fawn (*Cervus Dama*, Linn.), with the dura mater turned off from one side, to show the origins of the nerves arising from the medulla, and that the cauda equina is formed by the nerves after they have passed through the dura mater, as in the Porpesse : but here it may be observed, that after they have perforated the dura mater they do not run so obliquely downwards, and therefore the cauda is not so perfect."

It shows also the enlargement of the medulla at the lumbar region, where the nerves of the hinder extremities are given off; and the reflection of the arachnoid from the pia to the dura mater at the interspaces of the nerves, forming the 'ligamentum denticulatum'.

1366. A transverse section of the beginning of the spinal chord of an Elephant (*Elephas Asiaticus*, Blum.), it was put up "to show that there were two cylindrical portions of cineritious substance passing down the substance of the medullary."

A faint trace of the cineritious substances may still be perceived, but the colour has been almost effaced by long maceration.

1367. A similar specimen.

1368. The remaining part of the cervical with the commencement of the contracted dorsal portion of the spinal chord of the same Elephant. The dura mater is reflected from the dorsal surface, showing the loose arachnoid tissue which connects it to the pia mater; also the large size of the fasciculi composing the posterior roots of the spinal nerves, and their mode of origin.

1369. A portion of the spinal chord from the back of an Elephant, with the dura mater removed from both the anterior and posterior surfaces, so as to display the characteristic modes of origin of the two series of roots, which are very conspicuous in this large specimen. The posterior roots come off abruptly in a few, large, and distinct fasciculi; the anterior roots take their origin from a more extended surface of the spinal chord, and are numerous and small, converging and uniting to form several fasciculi before they finally pass through the dura mater. The reflection of the arachnoid tunic upon the sides of the chord in the interspaces of the nerves is also well displayed. This delicate membrane is strengthened along its free margin by a true ligamentous substance, which passes to the points of attachment to the dura mater in the usual crenate or denticulate manner.

1370. The remainder of the spinal chord of the same Elephant, including the commencement of the cauda equina. The dura mater is reflected from the anterior part of the chord, showing that it surrounds that part less closely than in the Cetacea, and that the roots of the nerves have therefore a longer course within the fibrous sheath.

1371. A section of the lumbar portion of the medulla spinalis of another Elephant. The dura mater is removed from both the anterior and posterior surfaces, showing the double origins of the nerves, and their extent within the fibrous sheath. The specimen is suspended by the thick ligamentum denticulatum. A small portion of the pia mater is reflected from the anterior surface of the chord, showing the process extended from its internal surface into the anterior longitudinal fissure of the chord. The corresponding process at the opposite side is seen in its place in the deeper posterior longitudinal fissure. A portion of the anterior columns of the chord are removed from the lower part of the preparation, showing the fibrils of the anterior roots passing a little way into the substance of the chord. A portion of bristle is placed behind these fibrils.

This beautiful preparation well illustrates the anatomy of the spinal chord.

1372. The termination of the spinal chord, with part of the cauda equina, of the same Elephant. The oblique section shows the depth of the posterior longitudinal fissure. The thickness and strength of the dura mater and ligamentum denticulatum are also well displayed in this preparation.

1373. The termination of the spinal chord, with the cauda equina, injected, of a Lion (*Felis Leo*, Linn.). The dura mater is reflected from the posterior surface, showing that it invests the chord closely at the upper part, but gradually recedes from it towards the cauda equina, inclosing there a considerable portion of the elongated roots of the last spinal nerves.

1374. The lumbar and sacral portions of the spinal chord, with the cauda equina, injected, of a young Lion; the dura mater is removed from the posterior part, showing the origins of the nerves; and that the cauda equina is composed partly of the nerves before they pass through the dura mater, and partly after. The spinal chord presents in this preparation a series of enlargements corresponding to the origins of the nerves.

1375. "Is part of the brain, and the whole medulla spinalis of a common Monkey. The dura mater is in part removed from the front part, and exposes the cauda equina, which is inclosed in that membrane. There is little or no difference between these parts in this animal and the human subject, only that the dura mater is not so large in proportion to the size of the medulla."

The enlargements of the chord corresponding to the origins of the nerves of the upper and lower extremities are well shown in this specimen.

1376. "Is nearly the whole length of the medulla spinalis, with the cauda equina, of the Human Subject. The dura mater is in part removed to show the medulla and the going out of the nerves through that membrane."

The cervical and lumbar enlargements of the spinal chord, the double origins of the spinal nerves, the difference in their mode of origin, the increasing obliquity of their course as they arise lower down the chord, and the ganglions formed on the posterior roots after they have passed through the dura mater, are all clearly shown in this preparation. The loose investment of the arachnoid membrane is also well displayed.

1377. "Is the termination of the medulla spinalis with the nerves cut off which formed the cauda equina, excepting the last nerve, which arises from the very termination of the medulla. It shows that the medulla is lengthened out in the form of a nerve, and, as it were, continued into the last nerve."

1378. The termination of the spinal chord, with the cauda equina of the Human subject; the nerves of the cauda equina are unravelled, giving it still more the characteristic appearance whence its name is derived.

1378 A. The lower moiety of the spinal chord and cauda equina, with the corresponding vertebræ of an Infant. The anterior and posterior parietes of the vertebral column and the dura mater have been removed, showing how comparatively loosely the chord is invested by the latter membrane, and the extent of the cauda equina contained in its sheath.

Mus. Heaviside.

D. *STRUCTURE AND COURSE OF THE NERVES.*

"The nerves are supposed to be continuations of the brain, even to their very extremities; but, as this cannot be demonstrated wholly from the nerves themselves (although some appear to favour this opinion), we must confine ourselves to reasoning from those appearances, and from the actions of the nerves in the animal machine.

"The optic nerve is the only one that appears to be a continuation of the brain; before it reaches the eye it loses a good deal of this appearance, but seems to acquire it again in the eye, where it is to receive the impression. The other nerves are most undoubtedly pulpy at their origins, and become less and less so to their exit from the skull, when they appear to be as firm as they are anywhere in the body.

"The nerves are whitish cords passing from the brain and medulla spinalis to all known parts of the body. They appear to be bundles made up of smaller bundles, and these made up of others still smaller, so that the supposed single nerve has not yet been seen.

"The nerves are regularly the same in every body; there are no varieties of situation, division, &c.*

"In many animals they have swellings upon them of different sizes and shapes, called ganglions; what these are is not yet known, but whatever they be, they are constant and regular. That the ganglions keep the same regularity as the nerves, is a circumstance very necessary to be known for the physiology.

"These ganglions are not so large in the Horse as they are in the Human." *Hunterian manuscript Catalogue.*

1379. Portions of two of the intercostal nerves of the Human subject, injected to show the vascularity of the neurilema, and unravelled at the lower part to show their component bundles.

1379 A. Two portions of the phrenic nerves of a Horse. One of these portions is shortened by the nervous fibres being thrown into serpentine folds; it was removed immediately after the horse was knocked down, and after a period of twenty-four hours was dissected to expose the state of the fibres. The other portion was removed from another horse which had died a natural death, and shows the condition of the nerve in its natural or elongated state. Both portions were of the same length when first removed; the cause and nature of the contraction of the shorter portion is disputed. Some Physiologists consider it to be the effect of the elasticity of the cellular texture of the nerve; others again, and amongst these the Physiologist by whose direction the present specimens were prepared, attribute it to a contractile power in the nervous fibre itself. See Home "On the Irritability of Nerves," *Phil. Trans.* 1801, Part I. Plate I. *Prepared by Mr. Clift.*

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* *i. e.* as compared with the arteries or veins; the varieties, however, in the division and origins of the nerves which have been noted are few and of little importance.

1380. The termination of the optic nerve, with the retina of the Human subject.

1381. One of the semilunar ganglions of the Human subject, injected and dissected, showing the divergence of the nervous fibrils in the grey substance of the ganglion, whence they are supposed to derive additional fibrils, and where they may probably enter into new combinations.

1382. One of the Human semilunar ganglions undissected, showing its large size.

1383. One of the corresponding semilunar ganglions of a Horse, to show the difference in their absolute and relative size.

1384. A Mackerel (*Scomber scombrus,* Cuv.), dissected, to show the course of the nerve forming the third division of the par vagum, or eighth pair of nerves. Each of these divisions is continued parallel with the lateral line of mucous ducts through the whole length of the body, and hence they are termed the 'lateral nerves'.

1385. The head of an Eel (*Anguilla longirostris,* Cuv.), in which the commencement of the lateral nerve, which is of large size, is shown on the right side. The branchiostegal membrane and its supporting rays, eleven in number, are displayed on the opposite side.

Subdivision VIII.

ORGANS OF SENSE.

" *General Observations on the Senses.*

" The Nerves, called the organs of sense, come immediately from the brain: how far they are to be considered as organs of sense, or only conductors of impressions, and the sensation being only in the brain, forming the mind, is not to the present purpose.

" When lecturing upon the nerves, we showed that they were the organs employed in sensation simply, so that a simple nerve conveys the impression. But there are modes of impression which a single nerve is incapable of receiving, therefore a peculiarity of structure of other parts, besides nerves, is necessary to give the disposition for receiving a peculiarity of impression, and to increase the power of these different modes of impression: such as the tongue to distinguish a quality that could not be made sensible to the skin; the nose to give in some degree the taste of bodies in a state of vapour; the ear to give the vibration of air or other bodies; and the eye for light. All of which circumstances could hardly have been made sensible to the mind without such structures of parts.

" Two of these organs of sense have nerves in common with all other parts, viz. those of the sense of touch and taste; but there are peculiar nerves for the other three.

" Four of the senses are placed in the head, viz. taste, smell, hearing, and seeing, but more especially the three last; the fifth is universal.

" As the impressions made upon these four organs are more delicate than touch, so we have the organ more delicately constructed. But even this was perhaps not sufficient; it was perhaps necessary that the organ should be near the brain before it could have its full force.

" These organs of intelligence have their degrees of superiority, being adapted to the various visible modifications of matter. The usefulness, and therefore the universality, of the sense is not the condition from which we should suppose it to be the most refined, but is rather the reverse. Yet perhaps the most common sense, as touch, and that we called the most refined, as seeing, are exactly similar in their mode of impression, although not in the mode of producing it.

"Two of the organs upon which sensation is placed are adapted to various other purposes, and therefore are not simply organs of sense, viz. those of touch and taste, but more especially the first, which is our director in all our mechanical operations.

"The tongue is also a very compound instrument; it is used by many animals as a catcher of the food, as in the Toad, Chamelion, Woodpecker, and Ant-Bear, and even in the Crow: it assists in drinking, as in the Lizard, Dog, &c.: it is one of the modulators of the voice in many animals: it is a scratcher of the skin in the Lion, Cat, &c.: and in some it is used for producing an agreeable sensation, such as licking, as in the Dog, for they generally lick whatever they are fond of.

"The other three senses appear to have their organs composed so as to answer no other purpose, although in some the organ of smell has an appendix which answers other purposes, and is necessary to be attached to the nose.

"Touch I call the first sense: it is the most simple mode of receiving impressions; for all the other senses have this of touch in common with the peculiar or specific; and most probably there is not any part of the body but what is susceptible of simple feeling or touch; yet the cutis is generally understood as the organ of touch.

"It appears that it is not necessary that there should be any particular structure of parts to enable the nerves in general to receive the impression of touch, as in the organs of hearing or seeing; or that matter should be particularly modified to give the impression, such as fluidity, which is necessary for giving the sensation of taste; vapour, which admits of giving smell; air for hearing; and light for seeing.

"In classing the senses we shall endeavour to arrange them according to their degrees of superiority; but we shall find it a difficult thing to divide each sense into its different class in different animals according to its perfection or superiority over the same sense in another animal: for such an undertaking it would be necessary that man should have first enjoyed the sense of each animal, so as to compare them in his own mind.

" If we consider sensation abstractedly from the mind, and only the acuteness of the impression, then the Human may perhaps come in last; but if we consider the mind, and the use that each sense is put to, then the Human will come in far before any. With respect to actual impression, a good deal of stress is to be laid upon the medium of impression, as air or water in hearing; for it is not necessary that the organ of hearing should be so perfect when water is the medium as when air is; nor will seeing be the same in water as in air.

" Perhaps temperature of body with respect to heat and cold may make a difference in all animals (it certainly does in the Human). A man feels more acutely when cold than when warm, but the delicacy of the touch when cold, or the intelligence to the mind, is not so perfect; so that acuteness of sensation and the information given by the sensation are not in the same proportion; but although this does not give the same information in the Human, yet it is very probable that it is all that is required in the Brute, &c.

" In some of the senses there are relative principles, as in hearing; for besides the immediate organ for the perception of sound, there is an external ear in some animals which is wanting in others, even where there is the same species of organ, which gives it a degree of superiority. Some animals have a property of a sense multiplied to an amazing degree, as is exemplified in the eyes of many insects; but perhaps this is not an advantage, as these eyes have no motion.

" The sense of touch appears to be in many animals so embarrassed with other matter, as external covering, that it would seem that they could hardly feel at all, such as the Lobster, &c. Yet if we consider that in many parts of the Human Being where the sense is the nicest, such as the ends of the fingers, that the part is there covered by a very thick cuticle, and when we observe that in the end of the foot in a Cow and Horse, which is covered by a thick hoof, there is all the appearance in the cutis of an increased apparatus for acute sensation, we must suppose that these coverings are not impediments to the sense of touch.

" Touch is the first sense, because no animal that has a sense (as far as I know) is without it, while there are many animals without the others.

" How far there are animals without taste I will not pretend to say. In the Catalogue I shall begin with the most simple and most common sensation; following the order of refinement and complication in the apparatus for sensation." *Hunterian Manuscript Catalogue.*

Series I. Organ of Touch.

" *Touch.*

" Although every part of an animal feels, yet the skin and all exposed parts are perhaps the most sensible of the simple impressions of touch*, and not only most sensible but most capable of distinguishing the different impressions, such as roughness, smoothness, heat, cold, &c. However, many internal surfaces are also capable of communicating many of the same sensations, such as the mouth, rectum, and urethra, for we are very sensible in those parts of heat, cold, &c. Nevertheless, we find the superficial surfaces more capable of giving with nicety the superficial structure of bodies than any of the others; and this much more so in some parts than others, such as the skin on the ends of the fingers, lips, glans penis, even the tongue. Perhaps this perfection of touch in some of these parts may in some degree arise from habit; however, we find the organ more perfect in those parts than in others, being covered by a structure which is fitted for the purpose of sensation, called villi, not of acute sensation but of delicate, or perhaps more frequently of distinguishing sensation. This is confined by an increase of this structure in those parts that are most sensible, as on the ends of the fingers, lips, &c.; and also in many animals where it was necessary for them to have the parts well defended from external injuries; such we

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" * Here I would be understood to make a material distinction between the sensation of touch, and irritation to action or pain."

find in all those animals which have hoofs; there the villi are very long and placed very thick and close.

"This structure is much better adapted for sensation than what a smooth surface possibly could be, because as we always feel a rough surface or body better than a smooth one, this roughness in ourselves supplies in some degree the place of roughness in the body touched.

"This structure, fitted for the impression of touch, is perhaps perfectly mechanical, being only adapted for the impressions of resistance*."

Hunterian Manuscript Catalogue.

1. *In Invertebrate Animals.*

1386. The oral disc, with the surrounding tentacles, or feelers, of a Sea Anemone (*Actinia*).

1387. A small Medusa (*Rhizostoma*), showing the marginal and central tentacula, by means of which it probably takes cognisance of objects with which it comes in contact, distinguishing such as are good for food from those which it ought to avoid.

1387 a. A small specimen of the Portuguese Man-of-war (*Physalia pelagica,* Lam.), showing the long and short tentacles extending from the lower part of the air-vesicle. *Mus. Leverian.*

1388. A fine specimen of the animal or soft parts of a Scallop (*Pecten maximus,* Linn.) minutely injected. The left lobe of the mantle and corresponding branchiæ have been removed, showing the fleshy organ which protrudes from the abdominal surface, and is called the foot. It terminates in an expanded disc, which is an organ of adhesion, and subservient to motion as well as touch. Numerous small tentacles or feelers are arranged along the thickened margin of the mantle; and the sense of touch is further exercised by the highly vascular fimbriated processes which extend from either side of the mouth, and are called the lips: their situation is indicated by a bristle which is placed in the mouth.

"* The sensation of heat and cold may be brought in as an objection to this idea; but heat and cold require perhaps no peculiarity of structure for receiving their impressions, it being that of simple sensation only, as of pain, &c."

1389. A Slug (*Limax ater*, Linn.), injected, showing the vascularity of the ventral disc or foot, in which part of the surface of the body the sense of touch may be supposed especially to reside.

1390. A Slug, injected, slit down the back and eviscerated, showing the foot and two of the tentacles, or feelers, extended.

1391. A Snail (*Helix Pomatia*, Linn.), prepared to show the different character of the surface of the skin in the exposed and protected parts of the body; in the latter it is thin and smooth, in the former thick, vascular, and rugose.

1392. A Snail, injected, slit down the back and eviscerated, showing the vascularity of the foot.

1393. A Snail, injected, with one pair of the tentacles, which serve as special instruments of touch, extended. The pulmonary cavity is laid open.

1394. The eight arms and two long tentacles which surround the mouth of the Cuttle-fish. These, besides being instruments of touch and exploration, serve more particularly as organs of prehension, being provided with numerous acetabula, or cavities especially constructed for adhesion to foreign bodies.

2. *In Fishes.*

1395. The termination of the snout of the Spotted Dog-fish (*Scyllium Canicula*, Cuv.), prepared "to show the manner of the nerves ramifying, as also their apparent termination in this part, each ultimate nerve appearing to terminate in the bottom of a tube or duct, the sides of which we may suppose to secrete, contain, and convey a thick mucous to the skin."

These mucous tubes serve as feelers.

1396. A portion of the lip of a Sturgeon (*Acipenser Sturio*, Linn.), showing the villi on that part.

1397. A portion of the skin of the snout, with the two barbs or tentacles of the same Fish. Bristles are placed in the orifices of some of the mucous tubes, which are situated abundantly on this part of the head.

1398. A portion of the under jaw, with the labial barb, of a Cod-fish (*Gadus*

Morhua, Linn.). The utility of the barb as an organ of touch is evinced by the fact that all the species of *Gadus* which are so provided are found to keep near the bottom, whence they principally derive their food, which consists of *Echini*, *Crustacea*, &c., while those of the genus which have no barbs at the mouth swim at a higher elevation than the others, and take their food principally as it swims.

Mr. Couch observes that the Cod possesses filaments between its teeth and lips that seem designed to enable it to discover and select its prey, and gives a remarkable instance of the perfection with which they fulfill that function. A codfish which was taken on a line at Polperro, Cornwall, "was distinguished," he relates, "by the striking peculiarity of wanting both eyes. The sockets contained no eyeball, and I am convinced that they never had existed, the common opake skin covering the sockets in a curiously reticulated manner; yet the fish was large and in good condition." (*Linn. Trans.*, vol. xiv. p. 72.)

3. *In Reptiles.*

1399. A small part of the body, with the right anterior extremity, of a Siren (*Siren lacertina*, Linn.). It is terminated by four straight digits, which, however, are mutilated in the specimen, being naturally provided with claws.

In the Siren the anterior extremities alone are developed.

4. *In Birds.*

1400. One of the feet of an Eagle (*Aquila*), with the cuticle removed to show the papillæ and cushions of the cutis on the under surface of the foot.

1401. A strip of cutis from the foot of the Ostrich (*Struthio Camelus*, Linn.), showing the papillæ or coarse villi on that part: they are very closely set, and about a quarter of an inch in length, placed parallel to one another, and perpendicular to the surface which is applied to the soil in walking.

1402. The cranium and upper mandible of a Spoon-bill (*Platalea leucorodia*, Linn.), minutely injected to show the great vascularity of the extremity of the dilated mandible, which in the natural state is covered with a soft cuticle, adapting it to the office of exploring in mud or sand for the small worms, mollusks, &c., which constitute the food of this Bird.

5. *In Mammals.*

1403. A section of the tail of a Porpesse (*Phocæna communis*, Cuv.), with the cuticle in part removed to show the villi of the cutis. "These villi," Mr. Hunter observes, "are soft and pliable; they float in water, and each is longer or shorter according to the size of the animal. In the Spermaceti Whale they are about a quarter of an inch long; in the Grampus, Bottle-nose, and Piked Whales much shorter; in all they are extremely vascular." (On Whales, *Phil. Trans.* 1787, p. 395.)

1404. A portion of the cutis vera 'of a Whale,' showing the villi.

1405. A section of the 'skin of a Whale.' Neither the part of the animal nor the species of Whale is indicated in the manuscript Catalogue. The long pointed villi of the cutis are well displayed in this specimen.

1406. A portion of the plicated integument from the under part of the neck or thorax of the Piked Whale (*Balæna Boops*, Linn.), showing the puckering of the softer skin in the interspaces of the longitudinal folds. "The skin is extremely elastic in the greatest number of quadrupeds, and in its contracted state may be said to be rather too small for the body; by this elasticity it adapts itself to the changes which are constantly taking place in the parts, and it is from the want of it that it becomes too large in some old animals. In all animals it is more elastic in some parts than others, especially in those where there is the greatest motion. How far these variations take place in the Whale I do not exactly know, but a loose elastic skin in this tribe would appear to be improper as an universal covering, considering the progressive motion of the animal and the medium in which it moves; therefore it appears to be kept always on the stretch by the adipose membrane being loaded with fat, which does not allow the skin to recede when cut. It is, however, more elastic at the setting on of the eyelids, round the opening of the prepuce, the nipples, the setting on of the fins, and under the jaw, to allow of motion in those parts; and here there is more reticular and less adipose membrane. But in the Piked Whale there is probably one of the most striking instances of an elastic cuticular contraction; for though the whole skin of the fore part of the neck and breast of the animal, as far down as the middle of the belly, be extremely elastic, yet to render it still more so it is ribbed longitudinally like a ribbed stocking, which gives an increased lateral elasticity. These ribs are, when contracted, about five eighths of an inch broad, covered with common skin of the animal; but in the hollow part of the rib it is of a softer texture, with a thinner cuticle. This part is possessed of the greatest elasticity; why it should be so elastic is difficult to say, as it covers the thorax, which can never be increased in size; yet there must be some peculiar circumstance in the œconomy of the species requiring this structure which we as yet know nothing of.

"The skin is intended for various purposes. It is the universal covering given for the defence of all kinds of animals; and that it might answer this purpose well, it is the seat of one of the senses." *Hunter, ut supra*, p. 396.

1407. A transverse section of the tail of a Beaver (*Castor Fiber*, LINN.): the scaly cuticle is removed, showing the corresponding indentations of the corium.

1408. A portion of the vascular downy integument from the growing antler of a Fallow Deer (*Cervus Dama*, LINN.). This is abundantly supplied with nerves and endowed with the requisite sensibility to warn the animal from such blows as might injure the growth or alter the form of the antler in its soft state.

1409. One of the nipples of a Mare (*fœmina Equi Caballi*), showing the soft naked papillose integument with which it is covered. Bristles are placed in the lactiferous ducts.

1410. The foot of an Ass (*Equus Asinus*, LINN.), injected, with the hoof removed to show the delicate elongated vascular laminæ and villi to which the corresponding inequalities of inner surface of the horny case are adapted.

1411. The foot of a young Foal (*pullus Equi Caballi*), similarly prepared, in which the vascularity of the villi of the cutis is better displayed.

1412. The foot of a slink Calf (*fœtus Vaccæ*), injected, showing the different states of the cuticular covering, which, although still thin and soft where the hoofs are afterwards to be perfected, is too dense at those parts to permit the vascularity of the corium to appear through.

1413. The foot of a Calf (*pullus Vaccæ*), injected, and the hoofs removed, to show the vascular laminæ and villi of the corium covering the last phalanges.

1414. The left fore foot of the Ratel, or Indian Badger of Pennant (*Ratelus mellivorus*, Bennett), showing the naked skin covering the soft cushions on the under surface of the toes.

1415. The fore and hind foot of the Grey Squirrel (*Sciurus cinereus*, Linn.), showing a similar provision for the exercise of the sense of touch in these parts by the absence of hair on the palm and sole.

1416. The hand of the Slow-paced Lemur (*Loris tardigradus*, Linn.), showing the dilated flattened extremities of the digits, and the flat, broad, but pointed conical nails supporting the extended surface of the tactile integument. Here the inner digit is directed laterally so as to act as an opposable instrument, or thumb, to the other digits.

1417. The foot of the same animal, showing a similar structure of the digits, except in the second, the nail of which is in the form of a long narrow claw, grooved below, and adapted to serve as a scratcher or cleanser of the fur.

1418. The foot of another Slow-paced Lemur.

1419. The hand and foot of a Mocock (*Lemur*, Geoffroy). They exhibit the same structure as in the Loris, except that the thumb of the hand is more in a line with the fingers.

1420. The hand of the Marmoset or Squirrel Monkey (*Callithrix Sciureus*, Kuhl).

1421. The hand of the Chimpanzee (*Simia Troglodytes*, Blum.).

1422. The foot of the same animal.

Here the hallux or great toe, although disposed so as to act as an opposable thumb, approaches more nearly to the proportions of the great toe of the Human subject than it does in any other species of the Quadrumanous order.

1423. The mask or skin of the head of the Blue-faced Baboon (*Papio Mormon*, Geoff.).

1424. The head of the Chimpanzee.

In both these species a greater degree of sensibility must exist in the naked parts of the face than in those animals in which the face is covered with hairs.

1425. The lower part of the face of a Human subject, injected, to show the vascularity of the highly sensible and delicate integument of the lips and nose.

1426. A portion of Human skin, showing the papillæ which appear from the corrugation produced by exposure to cold or other circumstances.

1427. A portion of Human skin which had been stretched by the growth of a subjacent tumour, showing the wrinkles produced by the contraction of the corium after the removal of the tumour.

1428. A portion of Human skin, injected, dried, and preserved in oil of turpentine, showing the vascularity of the corium, or *cutis vera*.

1429. A portion of Human skin, including the nipple and mammary areola, where the cutis is thin and highly sensible.

1430. A portion of Human skin, including the navel, which is everted.

1431. The left hand of a Woman, injected, with the cuticle removed to show the villi of the cutis.

1432. The left hand of a Woman, injected, dried, and preserved in oil of turpentine, showing the high vascularity of the integument.

1433. The last joint of a Child's thumb, injected, and the cuticle removed, to show the delicate vascular villi of the cutis.

1433 a. The hand of an Infant, minutely injected, showing the superior vascularity of those parts in which the sense of touch principally resides, viz. the extremities of the fingers. *Presented by Sir Wm. Blizard, F.R.S.*

1433 B. The hand of an Infant, with the arteries injected with mercury, dried and preserved in oil of turpentine, showing the rich network of vessels with which the fingers are surrounded.

Presented by Wm. Lawrence, Esq., F.R.S.

1433 C. A longitudinal section of one of the fingers of a Child's hand, similarly prepared, showing the plexus of vessels at the tactile extremity.

Presented by Sir Wm. Blizard, F.R.S.

1434. The right Human foot with the cuticle removed.

1435. The right Human foot, minutely injected and the cuticle removed, showing the superior vascularity of the extremities of the toes.

1436. The left great toe of the Human subject, similarly prepared.

1437. "The left hand of Thomas Beaufort, second son of John of Gaunt. Obiit A.D. 1424, ætat. 52. Efoss. Feb. 26, 1772." See *Phil. Trans.*, vol. lxii. p. 465.

1437 A. The right hand of the same body.

Presented by Sir Thomas Gery Cullum, Bart.

SERIES II. Organ of Taste.

" *Taste.*

" The sense of taste has an organ fitted for its reception, and nerves for its conveyance. It appears to have a greater analogy to touch than any of the others, and appears to be as universal, few animals being endowed with touch but what are most probably also endowed with taste.

" This organ is placed as a centinel at the beginning of the passage into the stomach, called the mouth, lying on the lower surface of that cavity, so that the substance to be tasted comes more readily in contact with the organ. It gives intelligence to the mind, which permits only such food to pass as is in general salutary.

" It is, in most animals a projecting body, but much more so in some than in others. Its shape is various, being in general nearly the shape of the lower jaw, in those animals that have that bone, as in Fish, Amphibia, Birds, and Quadrupeds; but in many other animals the shape is adapted to the various purposes or uses it is put to, as in the Bee, the Whelk; and in others it varies its shape considerably, according to the various motions it is performing, as in the Toad, Chameleon, Woodpecker, Ant-Bear; where, when at rest, it is of the same shape with the jaw, but when in use it forms itself into another shape.

"It has motions in all animals, but more so in some than in others: when its motion is least it is perhaps nearly simply the organ of taste, which is probably the case with most Fish; however, in many fish it serves as a retainer of the food, having teeth placed upon its surface, as in the Trout, and many other fish. The grinders and retainers are placed at its base; but in all those whose motion is considerable, it becomes a very compound instrument: it becomes in them not only the judge of the food brought in by other means, but it becomes the immediate instrument for providing, as in the Woodpecker, Chameleon, Toad, Bee, Fly, Whelk. It is most probably the conductor of the food into the œsophagus in all animals. Indeed, this instrument of taste is extended to various purposes, as in the Lion kind and Cow, for scratching; in all Quadrupeds and Birds, for the modulation of sound.

"Its structure varies equal to the various purposes, but the structure fitted for receiving the impression of taste is pretty similar in them all. The exterior or upper surface is principally the organ of taste, as the skin is the organ of touch. It is in general very villous, but this differs very much in different animals, which arises from animals appearing to differ very much in their acuteness and delicacy of taste, some being more obliged to the sense of smell than taste for the formation of their judgement in food.

"The tongue in all animals is most probably covered by a cuticle, at least in all that I am acquainted with. This covering, in those which (we may suppose) have the most acute taste, is very thin, as in the Human subject, Monkey; but in many others it is extremely thick and hard, being of the consistence of horn, such as the little claws on the tip of the Lion's tongue, the horn on the tip of many Birds' tongues."

Hunterian manuscript Catalogue.

1. *In Echinoderms.*

1438. " Part of the Priapus (*Holothuria tubulosa,* Lam.), showing the tentacles, which in this animal serve the purpose of tongues."

These tentacles are branched at the extremity, and communicate at the base with an elongated cyst. The secretion of this cyst is conveyed by a ramified duct to the divisions of the tentacle from the surface of which it exudes, and the extension of the tentacle is caused by the injection of the fluid of the cyst into its substance. With respect to the power which the tentacles are supposed by Mr. Hunter to possess of ascertaining the sapid qualities of the objects seized by them, it is probable from analogy that they are so endowed, since it has been shown by experiment that some of the lowest-organized animalculæ, as the Polygastric Infusories, exercise the sense of taste.

2. *In Insects.*

1439. The head, with the trophi, or oral organs, of a Humble Bee (*Bombus terrestris,* Latr.). The first or superior part, which is articulated with the head, is the short and broad *labrum,* or upper lip; on either side, and immediately below, this part are the short curved *mandibulæ*; below these, and separated from them by a pin, are the elongated jointed *maxillæ*; and below these again is the tongue, *lingua,* with two side processes, *palpi labiales*: these three parts are articulated with the *labium.* A bristle is placed in the *pharynx,* around the entrance of which this complex apparatus is arranged.

1440. The heads of two Humble Bees, with the oral organs differently displayed. In the upper specimen the *labrum, palpi labiales,* and *lingua* are seen from below, with the *maxillæ* protecting them laterally; in the lower specimen a side view of the same parts is given, the *mandibula* next the observer being removed.

In the following description of these parts by Mr. Hunter, the entomological names are subjoined, according to the nomenclature adopted in the 'Introduction to Entomology' of Kirby and Spence, vol. iii. p. 355.

" The tongue of the Bee is the first of the alimentary organs to be considered: it is of a peculiar structure, and is probably the largest tongue of any animal we know, for its size. It may be said to consist of three parts respecting its length, having three articulations. One, its articulation with the head, which is in some measure similar to our larynx. Then comes the body of the tongue, which is composed of two parts; one, a kind of base (*labium*), on which the other, or true tongue (*lingua*), is articulated. The first part (*labium*) is principally a horny substance, in which there is a groove, and it is articulated with the first (*mentum*): on the end of this is fixed the true tongue, with its different parts. These two parts of the tongue are as it were inclosed laterally, by two horny scales (*maxillæ*), one on each side, which are concave on that side next to the tongue; one edge is thicker than the other, and they do not extend so far as the other parts. Each of these scales is composed of two parts, or scales, respecting its length, one articulated with the other: the first of those scales (*cardo*) is articulated with the common base, at the articulation of the first part of the tongue, and incloses laterally the second part of the tongue, coming as far forwards as the third articulation: on the end of this is articulated the second scale (*lobus*), which continues the hollow groove that incloses the tongue laterally; this terminates in a point. These scales have some hairs on their edge.

" On the termination of the second part, is placed the true tongue, having two lateral portions or processes on each side, one within the other: the external (*palpus labialis*) is the largest, and is somewhat similar to the before-mentioned scales. This is composed of four parts, or rather of one large part, on which three smaller are articulated, having motion on themselves. The first, on which the others stand, is articulated at the edges of the tongue, on the basis, or termination of the last-described part of the tongue: this has hairs on its edge.

" A little further forwards on the edges of the tongue are two small thin processes (*paraglossæ*), so small as hardly to be seen with the naked eye. The middle part of all, of which these lateral parts are only appendages, is the true tongue (*lingua*). It is something longer than any of the before-mentioned lateral portions; and is not horny, as the other parts are, but what may be called fleshy, being soft and pliable. It is composed of short sections, which probably are so many short muscles, as in Fish; for they are capable of moving it in all directions. The tongue itself is extremely villous, having some very long villi at the point, which act, I conceive, somewhat like capillary tubes*.

"This whole apparatus can be folded up into a very small compass under the head and neck. The larynx falls back into the neck, which brings the extreme end of the first portion of the tongue within the upper lip, or behind the two teeth; then the whole of the second part, which consists of five parts, is bent down upon and under this first part, and the two last scales are also bent down over the whole; so that the true tongue is inclosed laterally by the two second horny scales, and over the whole lie the two first." *Hunter, on Bees, Phil. Trans.* 1792, p. 177.

3. *In Mollusks.*

1441. A Whelk (*Buccinum undatum*, Linn.), with its long proboscis protruded.

1442. A Whelk, with the proboscis retracted, dissected to show the exterior sheath of annular muscular fibres by the successive contractions of which the proboscis is protruded. The alimentary canal is injected with size and vermilion.

1443. A Whelk, with the proboscis protruded and laid open, to show the longitudinal muscles by which it is retracted, and the horny and spiny plates of the tongue.

1444. A Whelk, with the proboscis half protruded and laid open at its extremity, to show the armature of the tongue.

In this, as in the two preceding specimens, the branchial cavity is laid open, showing the two pectinated gills.

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* Mr. Kirby observes: "The upper part of this tongue is cartilaginous, and remarkable for a number of transverse rings: below the middle, it consists of a membrane, longitudinally folded in inaction, but capable of being distended to a considerable size; this membranous bag receives the honey, which the tongue, as it were, laps from the flowers, and conveys it to the pharynx."

1445. The soft parts of a Purple (*Purpura patula*, LAM.), with the head longitudinally bisected to show the tongue or proboscis, which is retracted.

1446. The soft parts of a Wreath (*Turbo Pica*, LINN.), with the head and retracted proboscis longitudinally bisected; the long horny lingual plate, with which the latter is armed, lies detached at the bottom of the bottle. The complex structure of this plate cannot be adequately traced by the naked eye; it is furnished with transverse rows of sharp-edged triangular teeth, there being from eight to ten in each row; the entire lingual plate supports many hundreds of the transverse rows, and consequently many thousands of the trenchant teeth. The plate itself, in its natural position, extends from the beginning of the floor of the mouth along the œsophagus to beyond the stomach; where it is disposed in a spiral form. Here it is of a soft texture, but it becomes harder anteriorly; and is continually advancing forwards, like the lingual teeth of the Ray and the grinders of the Elephant, to supply the place of the parts which are worn away by constant attrition at the front of the mouth.

4. *In Fishes.*

1447. The head of a small Sturgeon (*Acipenser Sturio*, LINN.), injected, with the mouth laid open on the right side to show the smooth, short, sessile tongue and palate.

1448. The anterior part of the head of the Grey Mullet (*Mugil Capito*, CUV.), showing the tongue *in situ*; its upper surface is smooth and hard, and is adapted to a corresponding smooth depression in the palate; the intermaxillary bones are protruded; the rising which fits into the depression at the middle of their under surface is not a part of the tongue, but of the lower jaw, behind which the tip of the tongue may be observed projecting freely forwards.

1449. The anterior part of an Electric Eel (*Gymnotus electricus*, LINN.), injected, with the mouth laid open on one side to show four series of irregularly-shaped, branched, fleshy processes or papillæ, projecting from different parts of the parietes of the cavity. One series is placed upon the tongue, where the processes are arranged in transverse rows: a second series is placed on the palate, opposite to the preceding, commencing by a point and widening as it proceeds to the gill-openings, where the processes are continued on to the branchial arches: the other two series are at the sides of the mouth, and are smaller than the palatal and lingual series. If, as is most probable, these papillæ have a similarity of function corresponding to their similarity of structure, and be equally the seat of taste, it would afford strong analogical evidence in favour of the opinion that the tongue is not the exclusive organ of that faculty in other animals.

5. *In Reptiles.*

1450. The tongue and os hyoides of the Menopome (*Menopoma Alleghaniense*, Harlan).

The tongue is little more than the membrane extended between the rami of the lower jaw, having a number of small and shallow follicles on the middle of its anterior part.

1451. The lower jaw, with the tongue *in situ*, of the Bull-frog (*Rana pipiens*, Linn.). The bifid posterior process of the tongue is raised and supported by a bristle. The anterior part of the tongue being closely tied down to the floor of the mouth, its ordinary position appears to be reversed, the fixed base being forwards, and the free moveable part turned towards the back of the mouth. By means of this singular disposition the tongue becomes, in the higher Batrachians, an important organ of respiration, closing the posterior nostrils like a valve during the act of swallowing the air, in the constant repetition of which the breathing of these animals consists.

1452. The tongue, larynx, and laryngeal pouch of the Chameleon (*Chamæleo planiceps*, Merrem). The tongue is retracted, so that only the bulbous and bifid extremity is seen in the mouth. The laryngeal aperture is laid open, and a black bristle is passed from it into the membranous and dilateable pouch below. A longitudinal piece has been removed from the under part of the bulbous extremity of the tongue, showing the fibrous sheath inclosing the glosso-hyal element of the os hyoides, which passes forwards into a cavity in the centre of the substance of the bulb, and contributes to support that part when in a state of retraction.

1453. The lower jaw and tongue of the same species of Chameleon. The bulbous extremity is drawn out of the mouth, and has been dissected to show its muscular structure and the sheath into which the glosso-hyal bone enters when the bulb is retracted. The ductile, elastic, and probably muscular structure intervening betweeen the bulb and the basi-hyal bone, and surrounding the sheath of the glosso-hyal, is dissected. The larynx and laryngeal pouch are well displayed, as in the preceding specimen. On the under side of the jaw the two longitudinal retractors of the tongue are shown.

1454. The anterior part of a Chameleon, with the cranium removed and the tongue still further extended, showing the ductile, semitransparent, intermediate substance which surrounds the sheath of the glosso-hyal; the origins of the retractors of the tongue are also exhibited.

1455. The larynx, os hyoides, and the tongue in its state of greatest extension, of a Chameleon. The intermediate substance between the bone and bulb, upon which the elongation of the tongue depends, has been carefully dissected. The larynx and laryngeal pouch are indicated by bristles. The following is Mr. Hunter's description of the anatomy of the tongue of the Chameleon, which is illustrated by the figures engraved in Plate XXXII. A. "The tongue of the Chameleon consists of four parts: first, a *bony basis*; second, a pulpy or *bulbous part* at the tip of the tongue; third and fourth, *elongating* and *contracting* parts, which run almost through the whole length.

" The *basis*, or bony apparatus of the tongue, consists of an os hyoides and os linguæ, somewhat similar to that of a Bird; therefore there is nothing very remarkable in their construction.

" The *bulbous*, or thick part at the end of the true tongue, is that part which is to manage the food when caught: it is the operator within the mouth; besides which it is the pincher or catcher, from its being formed at the end into two opposite points, similar to the Elephant's snout. This surface is rugous, and covered with a gelatinous slime.

" The basis and true tongue or tip are united by an elongating and contracting medium, which is very extensive. This length of tongue, its extension, and contraction, are very singular, and if well understood most probably very curious.

" The cause and mode of the contraction of its length are not uncommon. The elongation of the tongue in this animal is perhaps like nothing that we are acquainted with in an animal body.

" The apparatus for this purpose is a small rounded body which passes from the apex of the os linguæ [glosso-hyal] to the bulbous part, and then through the centre of the bulb. The part between bone and bulb consists of two different substances, one a whitish substance, which is the firmest, and appears to be capable of keeping its form ; the other is softer and more transparent. That part which passes through the bulb consists only of one substance, and appears to be a sheath for the reception of the os linguæ.

" The first of these [i. e. the whitish firmer substance] appears to be composed of rings, or something similar, placed obliquely in contrary directions, so as to appear to be two spirals crossing one another. Whether the other, or softer substance, has any direction of fibres I could not observe, but I suspect it is muscular. If I am right in my conjecture of this structure and of its disposition, it will be no difficult thing to show how it may be elongated ; for if these rings are placed transverse, they may be brought so near to one another as to shorten the whole very considerably ; and if they allow of being placed almost longitudinally, they must of course lengthen it very considerably, and this position can be easily produced by muscles, which I take the pulpy substance to be.

" The contraction of the tongue is owing to a degree of elasticity; but this appears to be only in the cellular membrane, acting as an assistant to the muscular. The muscular contraction is owing to two muscles, one on each side of the tongue; each arises from the os hyoides, on the inside of the os linguale, and passes along the side of the tongue to its bulbous part, but before it gets to the bulbous part it spreads itself all round.

" In the centre of each of these two muscles passes a considerable nerve to the bulbous part, and also two arteries. When the two muscles act, they draw the tongue back upon the os linguale, which, as it were, passes through the middle elongator, then through the centre of the bulb, till the whole tongue is retracted. Although this middle body is drawn upon the os linguæ, yet it does not appear to be a hollow, like a pipe; it rather appears to be filled with a very ductile cellular membrane, as in every part of the elongating division of the tongue, in order to allow of the great difference in the situation of parts with respect to one another."

Hunterian Manuscript.

1456. The os hyoides of a Lizard.

1457. The right ramus of the lower jaw, with the tongue and larynx *in situ,* and the sublingual pouch of an Iguana (*Iguana tuberculata,* Linn.). The apex of the tongue is bifid and tipped with horn; the whole of the dorsum and sides are minutely papillose. A bristle is inserted into the larynx.

1458. The left ramus of the lower jaw, with the tongue and larynx *in situ,* of White's Scincoid Lizard (*Tiliqua scincoides,* Cuv.).

The tongue is deeply cleft at the apex; the dorsum and sides are more coarsely papillose than in the Iguana. The laryngeal aperture is placed upon a rounded eminence; but, as in all the oviparous classes, is a simple fissure, undefended by an epiglottis.

1459. The lower jaw, tongue, and larynx of a Snake. In the Ophidian Reptiles the larynx projects still further than in the preceding specimen, and extends forwards above the tongue; this part is round, slender, and deeply bifid, and when retracted is received within a sheath beneath the larynx.

1460. The os hyoides, with the larynx and part of the trachea, of a Tortoise.

1461. The os hyoides, tongue, and larynx of a large Tortoise (*Testudo Indica,* Linn.). The tongue is remarkably beset with numerous elongated and pointed papillæ; the membrane of the fauces is smooth. A bristle is placed across the laryngeal aperture. The sublingual follicles are carefully dissected, and their excretory openings may be observed on either side the frænum of the tongue.

1462. The bones and cartilages of the os hyoides and larynx of a Turtle (*Chelonia Mydas,* Brongn.).

The body of the os hyoides, or basi-hyal, is cartilaginous, and is remarkably expanded. The lingual bone, or glosso-hyal, is articulated to its anterior apex; two short cartilaginous processes extend outwards and backwards from its anterior angles; two long bony processes are articulated to its sides; and, immediately behind these, two cartilaginous processes extend from its posterior angles. In the larynx may be observed the thyroid cartilage, which is of large size; the cricoid, which is small and imperfect, being confined to the posterior part of the larynx, where it supports the arytenoid cartilages.

1463. The tongue and larynx, with the os hyoides and part of the fauces, of a large Turtle, injected. The tongue is smooth, or devoid of papillæ, but is irregularly wrinkled; the membrane of the fauces, on the contrary, is provided with conical papillæ, which are continued, increasing in size, down the whole of the œsophagus, with their points directed towards the stomach (see Nos. 460, 461, 461 A). The laryngeal aperture is widely expanded; the larynx and trachea are laid open below.

1464. The bones and cartilages of the os hyoides and larynx of a Crocodile (*Crocodilus acutus*, Cuv.). The basi-hyal element of the hyoid apparatus is still more developed in the Crocodiles than in the Chelonians; but it has only one pair of lateral appendages, which are bony, and are the parts by which the tongue is suspended to the cranium. The broad anterior part of the hyoid cartilage supports a fold of the membrane of the mouth, which can be applied like a valve against a corresponding fold of the palatal membrane, so as completely to close the fauces (see vol. ii. p. 161. Plate XXVIII.).

The larynx is laid open posteriorly, showing the thyroid and arytenoid cartilages, the divided cricoid, and the imperfect rings at the commencement of the trachea.

1465. The lower jaw, with the tongue and larynx *in situ*, of the same species of Crocodile. The tongue has no projecting or moveable extremity, and is but slightly raised above the level of the membrane which attaches its circumference to the rami of the lower jaw; hence it was described by Aristotle as absent in the Crocodile, which he therefore compares in this respect to a Fish.

The group of glandular follicles on the dorsum of the tongue; the hyoidean valve, and the laryngeal aperture are well displayed in this specimen.

1466. A longitudinal section of the tongue, larynx, and beginning of the trachea of the same species of Crocodile. The extent of the cartilaginous basihyoid plate, which supports the entire larynx and carries above the level of the tongue the valvular fold above mentioned, is well displayed. The muscular structure of the tongue, the lingual follicles, the plicated faucial membrane, and the cartilages of the air-passages are also clearly exhibited.

1467. The tongue and fauces of a young Alligator (*Crocodilus Lucius,* Cuv.). The fold of the soft palate is here preserved; the wide fauces are laid open from above, and the trachea from below.

6. *In Birds.*

1468. The bones of the tongue and upper larynx of a Swan (*Cygnus Olor,* Briss.). By comparing this preparation with the figure of the os hyoides of the Pea-fowl (fig. 2. Pl. XXVIII. vol. ii.), the principal parts will be seen to correspond to those distinguished and named in the explanation of that figure (p. 162.). The glosso-hyal is broader and longer, corresponding to the greater development of the tongue in the lamellirostral swimming Birds, but is devoid of the cartilaginous processes appended to its posterior angles in the Gallinaceous tribe. In the larynx may be distinguished the thyroid, cricoid, and arytenoid cartilages, which in most Birds are more or less bony; the thyroid cartilage is the largest, and covers the whole of the anterior part of the larynx like a shield: the posterior broad part of the cricoid (which is not in this class developed in the form of a ring,) supports as usual the arytenoid cartilages, which form the rima glottidis; they have muscles for opening and closing that fissure, and the larynx is defended by the latter action alone from the entrance of food or fluid.

1469. The lower jaw, with the tongue and larynx, of a Swan (*Cygnus Olor,* Briss.). Here the tongue is so far developed as to correspond with the form of the lower jaw. It is a thick and fleshy organ, beset with four longitudinal rows of horny tooth-like processes, two at the sides and two on the dorsum, separated by a mesial furrow: the base of the tongue is also armed with retroverted spines arranged in a chevron figure; similar spines again occur behind the larynx. The apo- and cerato-hyal bones are dissected on one side, but covered by the muscles on the other.

1470. The tongue of the Flamingo (*Phœnicopterus ruber*, LINN.). It corresponds to the form of the lower jaw, which is suddenly bent downwards near its extremity: the tongue follows this bend and terminates in a point, which is tipped with horn; the dorsum at this part is smooth and flat, but at the straight part of the tongue it is rounded and singularly armed with a double series of long recurved spines; transverse rows of smaller spines project backwards from the base. The tongue is more bulky than is usually found in Birds; its substance, however, is not muscular, but is chiefly composed of an oily matter, contained in a loose cellular texture.

1471. A similar specimen.

1472. The tongue and larynx, with part of the faucial pouch, of the Pelican (*Pelecanus Onocrotalus*, LINN.). The chief peculiarity in this bird, with respect to the tongue, is the extremely small size of the glosso-hyal bone, and the corresponding smallness of the projecting part of the organ. The layer of cuticle, which lines the mouth and is continued over the tongue, has been removed.

1473. The tongue, os hyoides, larynx, and part of the trachea of the Gigantic Crane (*Ciconia Argala*, CUV.). Here the projecting part of the tongue is nearly as small, and quite as simple in form and structure, as in the Pelican; the horny sheath with which it is tipped is preserved. The larynx, in both birds, is partially defended by a process which projects half-way across it from the anterior side of the tube.

A structure not uncommon among Wading Birds may be noticed in the trachea in this preparation: the rings, which are always entire and in contact with one another in this class, are here alternately broad on one side and narrow on the other, so that the whole are firmly locked together, and guarded from lateral dislocation.

1474. The tongue, os hyoides, and larynx of an Ostrich (*Struthio Camelus*, Linn.), showing the small size of the tongue, which, on that account, and from its position, has been considered as an epiglottis, but which is supported by the basi-hyal element of the os hyoides. The larynx is widely open; its posterior margin is slightly elevated and is characterized by six obtuse processes. It rests upon the posterior part of the basi-hyal cartilage, which extends in the form of a long slender process beneath the commencement of the trachea.

1474 a. The lower jaw, with the tongue, fauces, and larynx of an Ostrich, in which the relative size and position of the tongue are advantageously seen. *Presented by Sir Everard Home, Bart.*

1475. The tongue, os hyoides, and larynx of a Rhea (*Rhea Americana*, Cuv.). In this Bird the tongue is relatively larger than in the Ostrich, and is studded over with minute black specks, which are the orifices of muciparous glands. The sides of the glottis are marked with oblique folds, and the posterior part of the larynx forms a series of eight obtuse processes.

1476. The same parts of the Cassowary (*Casuarius galeatus*, Briss.). The tongue is flat, thin, and serrate at the edges. The posterior margin of the larynx is slightly raised, and the sides are characterized by two oblique lines running forwards from the posterior part to near the extremities of the transverse membranous fold in front of the rima glottidis.

1477. The lower jaw, with the tongue and larynx, of a Woodpecker (*Picus*, Linn.). The tongue consists of two parts, viz. a fixed base and a projectile cylindrical portion, which is received, when retracted, into a sheath formed by the base. The extremity of the cylindrical tongue is tipped with horn.

1478. The head of a Woodpecker, showing the tongue in its retracted state.

1479. A similar preparation, with the tongue protruded. To accommodate this long prehensile instrument to the two states exhibited in these preparations, its cornua (apo- and cerato-hyals) are proportionally developed, and are reflected over the posterior and superior parts of the cranium, where they meet and are lodged in a groove; their extremities extending, when the tongue is retracted, to the base of the bill, as in the preceding preparation; but gliding backwards when the tongue is protruded, to the situation shown in the present one. The return of the cornua to the first position is assisted by an elastic ligament attached to their extremities.

1479 A. The head of a Woodpecker (*Picus viridis*, LINN.). In this species the mechanism for protruding and retracting the tongue is even more remarkable than in the preceding.

The cerato-hyals, or extremities of the cornua of the os hyoides, pass over the head and into the right nostril, where they appear to be fixed. The muscles which protrude the tongue take their origin from the cerato- and apo-hyals, and leaving these where they converge to enter the mouth, pass forwards to be attached to the lower jaw as a fixed point, from which they act with great advantage in jerking forwards the cornua of the os hyoides and the tongue. The retractor muscles are first wrapped four or five times round the trachea, which is their fixed point; they then pass along the sides of the larynx towards their insertion into the basi-hyal bone. The end of these contrivances for the rapid and extensive protrusion of the tongue is the transfixion of the insects which constitute the food of the Woodpecker, and which are dislodged from their hiding-places under the bark of trees by means of its powerful bill. For the more effectual retention of the stronger insects, it may be observed that the horny sheath at the tip of the tongue is barbed; the tongue is also lubricated by a glutinous secretion, abundantly furnished by the two large submaxillary glands, which may be seen extending from behind the angles of the lower jaw along the under side of the rami to the symphysis.

Presented by Wm. Yarrell, Esq., F.L.S.

1479 B. The tongue of a Toucan (*Rhamphastos*), showing its flat sheath of horn, with a series of short fine processes directed forwards on each side, like the barbs of a feather. The superior larynx, wide fauces, and beginning of the trachea are also preserved. The base of the tongue is soft and covered with fine papillæ; it forms posteriorly a denticulated ridge, which is directed backwards, and may serve to protect the laryngeal aperture like an epiglottis. *Purchased.*

1479 c. The tongue of a Lory (*Lorius Domicella*, Vig.). The tongue is short, thick, and fleshy, as in most of the Parrot-tribe; but it is further distinguished by terminating in a number of very delicate and close-set filaments, which can be protruded and expanded like a brush.

Prepared by Mr. Clift.

1480. The tongue and larynx of a Raven (*Corvus Corax*, Linn.). The tongue is broad and flat, sheathed with horn, and deeply cleft: its posterior angles are armed each with two strong retroverted spines.

1481. The tongue, larynx, and lower jaw of a Horned Owl, injected. The tongue exhibits little vascularity, except at the membranous space intervening between the retroverted papillæ on its base and the glottis. The orifices of numerous glands may be observed on either side the frænum linguæ.

1482. The tongue, larynx, and lower jaw of the Golden Eagle (*Aquila Chrysaëtos*, Vig.). The tongue is large and fleshy, divided into two lateral portions by a deep longitudinal furrow; at its base is a series of small retroverted spines arranged in the form of a chevron, between which and the larynx the surface is studded with the orifices of numerous glandular follicles: two rows of retroverted spines again occur behind the larynx. A row of glandular follicles is seen on either side the frænum linguæ, and a large cluster of similar orifices immediately anterior to it.

1483. The tongue and fauces of an Erne (*Haliæetus albicilla*,) showing the orifices of the glands analogous to the parotid, which are situated at the angles of the mouth.

1484. The tongue and larynx of the Osprey (*Pandion Haliæetus*, Sav.).

1485. The tongue and larynx of the King-Vulture (*Vultur Papa*, Linn.), showing the series of small retroverted spines along the lateral margins of the tongue, of which the sides are raised so as to render the dorsum concave.

In Mammals.

1486. The anterior part of the tongue of a Dolphin (*Delphinus Tursio*, Fabr.). It is thick and short; fringed along the margin with a number of irregularly elongated obtuse processes; flat and smooth on the upper surface, which is devoid of papillæ; and covered with a thick cuticle; the structure of the tongue is, therefore, evidently not adapted to the reception of delicate impressions of taste, but accords with the mode in which the food is taken, which does not undergo mastication, but is swallowed after a coarse division and laceration. (See the form and structure of the teeth, Nos. 327, 328.)

1487. A small section taken from the upper surface of the tongue of the Piked Whale (*Balæna Boops*, LINN.). It is covered with a cuticle devoid of papillæ, but is broken by irregular longitudinal furrows, and covered by small and singular wavy wrinkles. A layer of blubber is interposed between the skin and muscles of the tongue.

1488. A section of the upper surface of the root of the tongue of the 'Bottle-nose Whale' (*Delphinus* (*Hyperoodon*) *Dalei*, CUV.), showing numerous pores of glandular follicles, anterior to which are four large fossulate papillæ, with a few simple obtuse papillæ at the sides. The whole surface is irregularly wrinkled.

" The tongue, which is the organ of taste, is also endowed with the sense of touch. It is likewise to be considered, in the greatest number of animals, as an instrument for mechanical purposes; but probably less so in the Whale tribe than any other. However, even in these it must have been formed with this view, since, merely as an organ of taste, it would only have required surface, yet is a projecting body endowed with motion. In some it is better adapted for motion than in others; and I should suppose this to be requisite on account of the difference in the mode of catching the food and in the act of swallowing. It is most projecting in those with teeth, probably for the better conducting the food, step by step, to the œsophagus; whereas it does not seem so necessary to have such management of the tongue in those which have no teeth, and catch their food by merely opening the mouth and swimming upon it, or by having their prey carried in by the water. In the Porpoise and Grampus it is firm in texture, composed of muscle and fat, being pointed and serrated on its edges like that of the Hog.

" In the Spermaceti Whale the tongue was almost like a feather-bed.

In the Piked Whale it was but gently raised, hardly having any lateral edges, and its tip projecting but little, yet, like every other tongue, composed of muscle and fat. The extent between the two jaw-bones in this Whale was very considerable, taking the whole width of the head or upper jaw, and of course including the whalebone. This extent of surface, between jaw and jaw, having but little projection of tongue, is almost flat from side to side, is extremely elastic when contracted, and throws the inner membrane into a vast number of very small folds that run parallel to one another, but which are again thrown into a close serpentine course by the elasticity of the part in a contrary direction. From the tongue being capable of but little motion, there is only a small mass of muscle required; and from the thinness of the jaw-bones, the distance between the lower surface of the mouth and external surface of the skin is but small, and this skin being ribbed and very elastic, is capable of considerable distention, by which the cavity of the mouth can be enlarged.

" The tongue of the large Whalebone Whale I should suppose rose in the mouth considerably; the two jaws at the middle being kept at such a distance on account of the whalebone, so that the space between, when the mouth is shut, must be filled up by the tongue."

Hunter, on Whales, Phil. Trans., 1787, p. 426.

1489. The extremity of the tongue of the Elephant (*Elephas Asiaticus*, Blum.). It is very thick, deep, and short, of a rounded conical figure; numerous small obtuse papillæ are scattered over its surface, which otherwise is smooth. Bristles are placed in the ducts of the submaxillary glands.

1490. A section of the upper part of the base of the tongue of an Elephant, showing the large fossulate papillæ.

1490 a. The extremity of the tongue of a Hippopotamus (*Hippopotamus amphibius*, Linn.). It is thin and flat, a little widened at the extremity and slightly notched at the apex: numerous small conical papillæ are scattered over it. *Mus. Brit.*

1491. The tip of the tongue of a Hog, injected.

1492. A portion of the palate of a Hog.

1493. The tongue and larynx of a very young Hog (*Sus domesticus*, Linn.), "with the lower jaw covering over the upper," therefore a malformed specimen. The margins of the anterior half of the tongue are beautifully fringed with numerous long villi. At the base of the tongue there are two fossulate papillæ, behind which there are numerous coarse retroverted conical papillæ. The larynx is well defended by the epiglottis, the sides of which extend to the posterior part of the aperture.

1494. The extremity of the tongue of a Dromedary (*Camelus Dromedarius*, Linn.), showing the numerous small conical papillæ which give the villous character to its surface, and the larger obtuse papillæ scattered here and there, and which are most abundant on the under side near the margin of the tongue.

1495. Another section of the same tongue, including the raised portion which is situated in the molar region of the mouth; this part, in addition to the conical papillæ, which here acquire considerable size, has also a row of large fossulate papillæ on either side.

1496. The fauces of a female Dromedary, or One-humped Camel (*Camelus Dromedarius*, Linn.), showing the broad pendulous proccss or flap which extends from the anterior part of the soft palate, and which is here brought forward and rests upon the dorsum of the tongue. The velum palati extends a considerable way down the pharynx after having given off this process, and terminates by a slightly concave margin. The pharynx behind the velum is dilated posteriorly into a sac.

1497. The fauces, with the larynx, os hyoides, and root of the tongue of a male Dromedary. The pharynx is laid open on the right side to show the pendulous process of the soft palate, extending nine or ten inches down the pharynx, and passing below the margin of the soft palate and the opening of the larynx. The pharynx is considerably dilated posteriorly. It is supposed that by means of this mechanism the secretion from the extended glandular surface of the flap, and perhaps the water regurgitated from the cells of the stomach (see No. 567), is applied to the extended surface of the pharynx and the root of the tongue, so as to allay the feeling of thirst and enable the animal to endure the long remissions of drinking which its geographical position necessitates. The remarkable difference, however, which the structure above described presents in the male and female, would indicate that it was to a certain degree a sexual peculiarity; it must be observed, however, that the structure as it exists in the female may be adequate to produce the effect required in moistening the fauces and allaying the feeling of thirst.

On the left side of the present preparation, the os hyoides, the muscle extended between the anterior and posterior cornua, and the lower constrictor of the pharynx are shown.

1497 A. A part of the os hyoides and the epiglottis of a Camel, showing the long muscle called 'hyo-epiglottideus', which is extended between them.

Prepared by Mr. Clift.

1498. A portion of the palate of the Dromedary, taken from near the origin of membranous flap, which lubricates and moistens the fauces, showing its glandular structure.

1499. A portion of the membrane from the inside of the lower lip near the base of the tongue of the Dromedary, showing the large pointed processes at that part, and the groups of mucous follicles which pour their secretion upon it. Bristles are inserted into the ducts of these glands.

1500. Portions of the lips forming one of the angles of the mouth of a Dromedary, showing the inner surface beset with similar processes, most of them directed towards the fauces, whither they tend to direct the food during the process of mastication.

1501. The tongue and fauces of an Armadillo (*Dasypus novemcinctus*, Linn.). It is long, three-sided, and gradually diminishes to a point; the surface is minutely papillose, and towards the base of the tongue there are two fossulate papillæ. The emarginate apex of the epiglottis is seen projecting through the arch of the soft palate, in the middle of which there is a thickened part like a rudimental epiglottis.

1502. The head of the Little Ant-eater (*Myrmecophaga didactyla*, Linn.), with the lower jaw, and the long extensile, filiform tongue turned down, showing the two fossulate papillæ at its base, the palate, and the single horny molar plate on each side of each jaw.

1503. The lower jaw, tongue, and larynx of the 'Ant-Bear' (Quæ. *Myrmecophaga Tamandua*, Cuv.?). The tongue, although extended to nearly a foot in length, is not drawn out to its full length; when retracted it is received into a sheath, which passes in front of the larynx and trachea down the neck, and it has been cut across together with the sheath at this part. The tongue is abundantly lubricated by the viscous secretion of numerous glands arranged along the sides of the mouth, in addition to the secretion of the ordinary salivary glands: thus prepared, it is stretched out in the vicinity of some ant-hill, and withdrawn from time to time with the adherent insects, which are swallowed for food. Some of the long cuticular retroverted setæ with which the anterior part of the dorsum of the tongue is armed, are preserved in the preparation.

1503 A. The tongue of the Spiny Ant-eater (*Echidna Hystrix*, Cuv.). It resembles in its vermiform shape and extensibility that of the true Myrmecophagæ, but is armed at its expanded base with numerous cuticular retroverted spines. *Presented by Sir Everard Home, Bart.*

1503 B. The tongue of the Ornithorhynchus (*Ornithorhynchus paradoxus*, Blum.). It is divided into two parts; one anterior, beset with numerous coarse papillæ; the other posterior, broad, raised above the level of the first, and projecting over it; this part is armed anteriorly with two strong spines, directed forwards, which probably serve to prevent the passage into the fauces of such substances as ought first to undergo mastication and maceration in the cheek-pouches. Behind this raised part of the tongue is seen the larynx, defended by a large triangular epiglottis; a part which essentially characterizes the mammiferous class, to which this singular animal is now proved to belong.

Presented by Sir Everard Home, Bart.

1504. The tongue and larynx of the Vulpine Opossum (*Phalangista vulpina*, Geoffr.), injected. The tongue is thick, covered with very minute villi, and has three fossulate papillæ near its base. Bristles are placed in the glandular cavities representing the tonsils.

1505. The tongue of a young Kangaroo (*Macropus major*, Shaw). It is similar to the preceding, being minutely villous, and characterized by three fossulate papillæ near its base.

1506. The tongue of the Paca or Spotted Cavy (*Cœlogenys subfusca,* F. Cuv.). The compressed and deep form which the tongue here presents is common to all the Rodent quadrupeds, their mouths being narrow from side to side, but extended from above downwards. The tongue is large, and fills pretty accurately all this space, bearing commonly the impress of the palatal furrows on its dorsum, and of the grinding teeth on its sides; its free apex is short and obtuse; and in many species it presents, as in the present example, a sudden elevation corresponding to the molar region of the mouth.

1507. The anterior part of the jaws and tongue of a Rabbit (*Lepus Cuniculus,* Linn.). The smooth anterior part of the tongue exhibits the impression of the oblique palatal ridges which are shown on the upper jaw; the commencement of the raised molar portion of the tongue is preserved. The bifid upper lip and the hairy integument continued into the cavity of the mouth on each side, which are common to the Rodentia, and the small posterior incisors of the upper jaw, characteristic of the genus *Lepus,* also deserve notice. The arteries of one side of the head only have been injected, showing the very little communication which subsists between them and those of the opposite side either in the upper or lower jaw.

1508. The tongue and larynx of a Seal (*Phoca vitulina,* Linn.), showing its bifid extremity fringed with delicate papillæ, its flattened upper surface, and the fossulate papillæ and rugæ at its base. The tonsillar cavities and glands are indicated by black bristles.

1509. The tongue and larynx of a young (Lion *Felis Leo,* Linn.,) injected. The tongue is of considerable length in consequence of the distance at which the larynx and os hyoides are placed behind the bony palate. The soft palate is of a proportional extent. All that part of the tongue which corresponds to the soft palate is smooth; as it advances forwards it is covered with large soft papillæ directed backwards; then there are four large fossulate papillæ, anterior to which the simple conical papillæ continue increasing in size to near the tip of the tongue: the strong cuticular spines with which they are armed have been removed, showing the vascular secreting surface beneath. With the larynx there are preserved the thyroid glands and part of the wide trachea.

1510. A portion of the cuticular covering of the smaller posterior conical papillæ, from the preceding tongue.

1511. A portion of the cuticular covering of the anterior papillæ of the same tongue. At the fore part of the base of each of the larger spines may be observed a group of small gustatory papillæ.

1512. The extremity of the tongue of a Lion, with the cuticular covering of the papillæ removed from one side.

1513. The anterior part of the tongue of a Lion, with the cuticular and spiny covering of the papillæ preserved. The roughness which we feel in the cat's tongue is produced by similar horny or cuticular spines, which are here shown on a large scale.

1514. The tongue and larynx of a Hyæna (*Hyæna striata*, Zimmermann), showing a circular group of retroverted spiny papillæ on its anterior part, and coarse soft papillæ at its base. The ligamentous rudiment of the glossohyal, commonly called the 'lytta' or 'worm,' is shown at the under part of the tip of the tongue; it is firm and elastic, and probably assists in the act of lapping. The tonsils are relatively larger than in the Lion.

1514 a. The tongue of a Jackal (*Canis aureus*, Linn.), showing the 'worm.'
Prepared by Mr. Owen.

1515. The tongue of a Dog (*Canis familiaris*, Linn.).

1515 a. The os hyoides of a Polar Bear (*Ursus maritimus*, Pall.).
Presented by W. E. Leach, M.D. F.R.S.

1515 b. The dilated extremity of the tongue of the same. Its upper surface is characterized by a mesial longitudinal groove, and by the close-set, small, equal-sized papillæ: the sides of the under surface are beset with coarser papillæ. *Presented by W. E. Leach, M.D. F.R.S.*

1516. The tongue, larynx, and part of the trachea of the Mocock, or Ruffed Lemur (*Lemur Macauco*, Geoffr.). The tongue is broad, covered with small, soft, conical papillæ, among which obtuse papillæ are interspersed. A long, pointed, flattened process, bifid at the apex, is continued forwards from the frænum linguæ. The soft palate terminates below in a concave margin, without an uvula. The epiglottis is remarkable for its size. One of the lobes of the thyroid gland is preserved, which is of large size; it may be observed that the rings of the trachea are entire.

1517. The tongue of another Lemur, showing two smaller frænal processes beneath the larger one noticed in the preceding description. The parts are injected, and the cuticular covering removed from the apex of the tongue, showing the vascularity of the subjacent surface. The larynx is laid open to display the large size of the epiglottis, the lateral sacculi, and the chordæ vocales.

1518. The tongue of the Slow Lemur (*Loris tardigradus*, GEOFFR.). It is of a similar structure with that of the Mocock, and has corresponding processes projecting forward from the frænum.

1519. The tongue and larynx of the Mandrill (*Papio Mormon*, GEOFFR.). The dorsum is covered with minute conical papillæ, and obtuse papillæ interspersed at pretty regular distances: at the base of the tongue there are three large fossulate papillæ. The soft palate is preserved with the short uvula. The larynx is laid open, showing the lateral sacculi and the commencement of the mesial pouch, which is continued forwards between the thyroid cartilage and os hyoides to the front of the neck; a large bristle is passed through this aperture.

1520. The root of the tongue, with the fauces and larynx, of a Baboon (*Cynocephalus*, CUV.). The soft palate and uvula are preserved *in situ*; and the anterior projection of the dilated body of the os hyoides, corresponding to the anterior sacculus of the larynx, is also shown.

1521. The root of the tongue, velum palati, and uvula of a Baboon (*Cynocephalus ‘Sphingiola*, HERMANN’?).

1522. A section of the tongue of the same animal, showing the depth to which the fossulate papillæ extend.

1523. The tongue, with the soft palate, uvula, and larynx of a Gibbon (*Hylo-*

bates Lar, Cuv.). The tongue is shorter in proportion to its breadth in the Mandril, but presents a similar structure and disposition of papillæ.

1524. The lower part of the face of a Human Child, with the tongue, pharynx, and larynx *in situ*. The tongue is broad and short, corresponding to the form of the lower jaw; its apex is protruded, and shows the filiform and the erectile, gustatory, fungiform papillæ with which it is beset.

1525. The tongue of a Child, showing the different kinds of papillæ on its dorsum, and the glandular depression at the back part of the tongue called the foramen cæcum. The tonsils and larynx are preserved.

1526. The Human tongue, minutely injected.

1526 a. The Human tongue, into which fine injection has been thrown by one of the lingual arteries, which colours only the corresponding side of the tongue, in consequence of the very slight anastomosis which takes place between the arteries of the two sides. The left side is here injected; and it may be observed, that the azygous fossulate papillæ at the apex of the chevron formed by these glands, is injected.

Presented by Sir Wm. Blizard, F.R.S.

Series III. Organ of Smell.

"The sense of Smell has an organ for receiving the impression called the Nose. I suspect it is not so universal as what taste is; at least no organ that can give the idea is found in many of the more imperfect animals, and even in one tribe of the more perfect.

"The organ of smell is a simple organ, being principally fitted for this sensation, and therefore presenting less variety than the organ of taste. However, the organ may be said to answer other purposes, as it gives passage to the air for respiration; so that the two purposes are answered by the same act. Besides, in some animals it is elongated so as to act as an extremity or arm, as in the Elephant; or to dig, as in the Hog: but in these cases this elongation is only to be considered as a useful part placed here for the convenience of the organ of smell, as this extremity is generally employed in the affair of food.

It is situated (as far as I know) near to, and above, the mouth in all animals.

" In the Fish, which is the most imperfect animal that I know which has this sense, the organ is distinct from all others ; but in the Amphibia, Bird, and Quadruped, it communicates with the mouth. This situation allows it to be an assistant to taste, or rather the remote judger of proper food, while taste may be reckoned the immediate : for the body which possesses the quality of odour, need not itself be in contact with the organ, but only the parts possessing that quality raised into vapour, and that vapour making the impression ; or the substance becomes soluble in water, and that water coming in contact with the organ, which becomes similar to taste. This happens to be the case with fish, which is no more than smelling the medium in which they live, so that smell becomes much more extensive in its mode of reception than what taste is ; and, indeed, I believe it in the same proportion more useful to those animals which have both : for many animals might do very well without taste, which would do very ill without smell, as the Dog, Fox, Wolf, Lion, Cow, Horse, &c. Indeed, in such it would be extremely inconvenient not to have it, for the operation of tasting is considerable, requiring a movement of the body to be tasted, and also to undergo a change, while smell is done at once.

" As the mode of application of the matter which makes the impression in smell, is more delicate than in touch, the organ is also more delicate in its structure. The structure in the sensitive part appears to be pretty much the same in all the animals possessing this organ : it is a spongy or soft membrane and very vascular ; which is known by injection. It does not appear to be covered by any cuticle. The acute reception of smell to the mind is caused by quantity, therefore the surface of impression is extended or increased, and more especially in those animals which are to, or can, distinguish their food by this sense alone, and still more so in those which are to go in search of it by the smell, such as the Dog, &c.

" The operation of smell is performed, I believe, in the act of respiration in all animals that breathe air; and in all, excepting man, this operation of respiration is principally performed through the nose, so that the passage in them answers two purposes.

" Smelling is no more than the atmosphere or medium in which the animal lives being impregnated with such matter as to make an impression on the organ; therefore the air becomes the medium to the aerial, and water to the aquatic. There is, however, a tribe of animals whose construction is that of the most perfect, but which live entirely in water, which search and catch their food in water, yet from their general construction they must breathe air.

" Here arises a difficulty: an animal to breathe air which it need not smell, and not to breathe water which it should smell, if smelling were necessary; and to make a water-nose, was making it, in this respect, like a fish, which would be deviating from the first principle: therefore nature has made them entirely without the organ of smell."

Hunterian manuscript Catalogue.

1. *In Fishes.*

1527. A section of the head of a Sturgeon (*Acipenser Sturio*, Linn.), including the organ of smell of the right side. The olfactory nerve, which is of large size, is cut obliquely across; it expands at its termination upon the back part of the pituitary membrane, which is contained in a cavity of a semicircular form, and is disposed in a series of deep but thin semilunar folds, which radiate from a ligamentous centre.

1528. A section of the head of a Skate (*Raia Batis*, Linn.), including the organ of smell. In this species the central ligament to which the olfactory laminæ are attached, is extended across the long axis of the nasal depression, and the laminæ are continued at right angles to it and parallel to one another to the circumference of the cavity; half-way towards which a triangular process is extended forwards from the margin of each. The external entrance to the cavity is defended by an opercular fold.

1529. A section of the head of a Fire-flare (*Trygon pastinaca*, Cuv.), including the lower lip and the organs of smell; showing the position of the external orifices of the latter with respect to the mouth and the disposition of the olfactory laminæ.

1530. A section of the organ of smell of a Shark (*Squalus Galeus*, Cuv.), showing the elongated bulbous termination of the olfactory nerve, extending behind the ligamentous commissure of the olfactory laminæ: black bristles are placed on each side of the nerve. The external surface of these laminæ is very much increased by being thrown into close-set transverse folds; the angular processes of the laminæ extending outwards between the ligamentous commissure and the periphery of the nasal cavity are much larger than in the Skate; but, as in that fish, the laminæ are parallel to one another. With respect to the olfactory sense in fishes, Mr. Hunter asks, "Is the mode of smelling in fishes similar to tasting in other animals? Or is the air contained in the water impregnated with the odoriferous parts, and is it this air the fish smells? If so, it is somewhat similar to the breathing of fish, it not being the water which produces the effect there, but the air contained in it. This I proved by experiments, which are mentioned by Dr. Priestley." *Philosophical Transactions*, 1787, p. 428.

2. *In Reptiles.*

1531. A section of the anterior part of the head of an Iguana (*Iguana tuberculata*, Linn.), including the left cavity of the nose and the corresponding olfactory nerve, the latter is of small size, and is continued along a groove by the side of the upper part of the septum narium to the nasal cavity. A single broad turbinated cartilage extends into the cavity from the outer side, and terminates at its lower part in two tuberosities placed one behind the other. The nasal meatus extends at first longitudinally backwards to the upper part of the turbinated cartilage, and then bends vertically downward to terminate in the mouth half-way between the anterior maxillary and palatal teeth. A bristle is placed in the nasal passage.

1532. A longitudinal section of the anterior part of the head of a Turtle (*Chelonia Mydas*, Brongn.), including the left side of the organ of smell; the external orifice is a simple oval aperture, beyond which the cavity suddenly expands to contain the turbinated cartilage and pituitary membrane: a part of the latter has been dissected to show the fibres of the olfactory nerve expanding upon the cartilage.

1533. The opposite section of the same Turtle's head, with the olfactory nerve similarly dissected. In both preparations the parts are finely injected.

1534. A section of the head of another Turtle, showing both olfactory nerves, with the septum narium, the two turbinated cartilages, and the anterior part of the nasal passages. The one on the left side is laid open, the other is left entire, and the fibres of the nerve which spread over the outside of the turbinated cartilage are shown.

1535. The turbinated cartilages and the cartilaginous septum narium of a Turtle.

3. *In Birds.*

1536. A longitudinal section of the head of a Swan (*Cygnus Olor*, Briss.), including the septum narium here covered with a rugose pituitary membrane, the vascularity of which is shown by the successful injection of size and vermilion. In this bird the septum is incomplete at its anterior part, opposite the external nostrils. Two bristles are passed from the external ear through the Eustachian tube which communicates with the fauces just behind the posterior or internal aperture of the nostrils. The lachrymal canal is laid open externally, together with the air-cavities anterior to the orbit. Above the bristle, which is passed through the lachrymal passage, may be seen the nasal gland, which is situated above the orbit.

1537. The opposite section of the same head, showing the three spongy or turbinated cartilages, of which the middle one is considerably the largest, and the membranc which covers it the most vascular. Two bristles are passed through the lachrymal ducts which open between the inferior and middle cartilages. Bristles are also passed from the ear into the Eustachian tube and through the air-cavities at the anterior part of the orbit.

1538. A longitudinal section of the anterior part of the head of the Golden Eagle (*Aquila Chrysaëtos*, Vig.), showing the turbinated cartilages and cavity of the nose, together with part of the orbit and the air-cell continued from it anteriorly, and situated below the nose. The parts being minutely injected, the vascularity of the pituitary membrane covering the middle turbinated cartilage is well displayed. Portions of the eye and eyelids, with the nictitating membrane, are preserved, showing the situation of the two puncta lachrymalia, through which bristles are passed along the ducts to the nose.

1539. A transverse section of the head of an Erne (*Haliæetus albicilla*, SAV.), showing the convolutions of the middle turbinated cartilages, and the disposition of the pituitary membrane, which is thickest on the convex or mesial side of the convolutions. The air-cells in the superior maxillary bones and their communications with those which are situated in front of the eyeball, are well seen in this preparation. Bristles have been inserted into the lachrymal ducts and into the common termination of the Eustachian tubes, the respective conduits of the eye and ear for conducting their superfluous moisture to the nasal passages.

At the back part of this preparation the left eyeball is laid open, showing the marsupial membrane. The right eyeball is entire, and the abductor, attollens, and deprimens oculi, together with the quadratus and pyramidalis muscles of the membrana nictitans are well displayed.

1540. An anterior transverse section of the head of the same Eagle, showing the external nostrils, the anterior terminations of the middle turbinated cartilages and of the lachrymal ducts, in which bristles are placed; together with the communications of the maxillary air-cells with the cancellous structure of the upper mandible.

4. *In Mammals.*

1541. A section of the integument covering the upper part of the head of a Porpesse (*Phocæna communis*, CUV.), including the external orifice of the nasal passages, or blow-hole: it is single and of a crescentic figure, with the convexity turned forwards.

1542. A section of the upper part of the head of a Porpesse, showing a portion of the valvular apparatus for closing the blow-hole: this consists of an extended elastic integument, lining a cavity at the posterior part of the termination of the nasal passage; when the cavity is empty the membrane is thrown into irregular transverse folds, which press forwards against the opposite or anterior side of the passage, and oppose the entry of water by the blow-hole. Below these folds, on the posterior part of the passage, there are two valvular prominences which pass like the bolts of a double lock into corresponding cavities or sockets on the opposite side; these cavities are shown in the present specimen. The external opening is further defended by a strong sphincter muscle.

1543. A section of the head of a Porpesse, including the posterior parietes of the common termination of the nasal passages with the plicated and dilatable folds of soft elastic integument above described, and the valvular processes which lock into the cavities of the opposite side. The folds are preserved entire on the right side, but have been cut across on the left to show the depth of their plications. See *Gallery Catalogue*, vol. ii. p. 107. pl. 29.)

1544. A section of the head of a Porpesse, including the whole valvular apparatus for closing the nasal passage below its dilatable terminal cavity; the processes or bolts are here withdrawn from their sockets, and a quill is passed through the plicated receptacle and blow-hole: when this receptacle is distended with water, and the surrounding muscular structure is in action for the purpose of forcibly expelling its contents, then the bolts are, by the same action, firmly fixed into the opposite sockets, and the fluid in the receptacle is necessarily expelled or spouted by the external opening.

1545. A section of the upper part of the head of the Piked Whale (*Balæna Boops*, LINN.), showing the external orifices of the nasal passages, or blow-holes, distinct from one another. The left blow-hole is laid open, showing the corrugated surface of the lining membrane, and the continuation of the rete mucosum into the cavity; the right blow-hole is preserved entire, together with the valvular protuberance by which it is defended.

1546. A section of the head of the Piked Whale, including a portion of one of the nasal passages, with the turbinated bone and pituitary membrane, which is supported by a plexus of vessels.

" In this tribe of animals there is something very remarkable in what relates to the sense of smelling; nor have I been able to discover the particular mode by which it is performed.

" When we consider these animals as quadrupeds, and only constructed differently in external form for progressive motion through water, we must see that it was necessary that all the senses should correspond with this medium: we must therefore be at a loss to conceive how they smell, since we observe that the organ for smelling water, as in Fish, is very different from that formed to smell air; and as we must suppose this tribe are only to smell water, being the medium in which such odoriferous particles can be diffused, we should expect their organ to be similar to that of Fish: but in that case nature would have been obliged to have attached the nose of a Fish to an animal constructed like a quadruped; and it is contrary to the laws which are established in the animal creation to mix parts of different animals together.

" In many of this tribe there is no organ of smell at all; and in those which have such an organ, it is not that of a Fish, therefore probably not calculated to smell water. It becomes difficult, therefore, to account for the manner in which such animals smell the water; and why the others should not have had such an organ, which, I believe, is peculiar to the large and small Whalebone Whales.

" Although it is not the external air which they inspire that produces smell, I believe it is the air retained in the nostril out of the current of respiration, which by being impregnated with the odoriferous particles contained in the water during the act of blowing, is applied to the organ of smell. It might be supposed that they could smell the air on the surface of the water by every inspiration, as animals do on land, and probably they may; but this will not give them the power to smell the odoriferous particles of their prey in the water at any depth; and as their organ is not fitted to be affected by the application of water, and as they cannot suck water into the nostril, without the danger of its passing into the lungs, it cannot be by its application to this organ that they are enabled to smell.

" Some have the power of throwing the water from the mouth through the nostril, and with such force as to raise it thirty feet high: this must answer some important purpose, although not immediately evident to us.

" As the organ appears to be formed to smell air only, and as I conceive the smelling of the external air could not be of use as a sense, I therefore believe that they do not smell in inspiration; yet let us consider how they may be supposed to smell the odoriferous particles of the water.

" The organ of smell is out of the direct road of the current of air in inspiration; it is also out of the current of water where they spout; may we not suppose then that this sinus contains air, and as the water passes in the act of throwing it out, that it impregnates this reservoir of air, which immediately affects the sense of smell? This operation is probably performed in the time of expiration, because it is said that this water is sometimes very offensive; but all this I only give as conjecture.

" If the above solution is just, then only those which have the organ of smell can spout, a fact worthy of inquiry.

" The organ of smell would appear to be less necessary in these animals than in those which live in air, since some are wholly deprived of it; and the organ in those which have it is extremely small when compared with that of other animals, as well as the nerve which is to receive the impression, as was observed above."

Hunter, On Whales, Phil. Trans. 1787, p. 428.

1546 A. A longitudinal section of the head of the Ornithorhynchus (*Ornithorhynchus paradoxus*, BLUM.), showing the bony septum narium, and some filaments of the olfactory nerve descending upon it; also the external nostril, the long nasal passage, with its anterior communication with the mouth by the foramen incisivum, and its posterior aperture beneath the basis cranii. In the cavity of the cranium may be observed the bony falx.

Presented by Sir Everard Home, Bart.

1546 B. A longitudinal section of the head of the Echidna (*Echidna Hystrix*, Cuv.), showing the long nasal passage of the right side, and the turbinated bones, of which the superior is extremely complicated, being composed of a series of vertical processes, which expand and subdivide as they proceed downwards. *Presented by Sir Everard Home, Bart.*

1547. A longitudinal section of the Human face, minutely injected, showing the septum narium covered by the pituitary membrane, through which the filaments of the olfactory nerve may be seen radiating from the cribriform plate of the ethmoidal bone. The frontal and sphenoidal sinuses above the septum are laid open; and behind the septum is seen the expanded extremity of the Eustachian tube, in which a small quill is introduced. The relative positions of the tongue, soft palate and uvula, pharynx, epiglottis, larynx, and sacculus laryngis, are well displayed in this section.

1548. The opposite section of the same head, showing the three turbinated or spongy bones dividing the nasal cavity into three passages or ‘meatuses.’ The superior meatus is the smallest; it is situated between the superior and middle spongy bones; bristles are passed into it from the posterior ethmoidal cells and the sphenoidal sinus, both of which communicate with it. The middle meatus is situated between the middle and inferior turbinated bones; a portion of the former is removed, which exposes the small opening leading into the maxillary sinus or ‘antrum of Highmore’; the frontal sinus is also in communication with this meatus, and a bristle is passed from the one to the other. The inferior meatus, which is situated between the inferior spongy bone and the roof the mouth, receives the termination of the lachrymal duct; in order to show which, a portion of the inferior spongy bone has been raised, and a bristle inserted into the orifice of the duct. The Eustachian meatus communicates with the nasal cavity about half an inch behind the posterior extremity of the inferior spongy bone. A small quill is placed in its expanded termination, which is bounded above by a valvular thickening of the glandular mucous membrane. The structure of the fauces, larynx, and pharynx is seen to the same advantage in this as in the preceding specimen.

1549. A transverse section of the Human head, showing the convolutions of the spongy bones, the meatuses, and septum of the nose, together with part of the maxillary sinuses; and also affording good anterior and posterior views of the fauces. The soft palate and uvula constituting the muscular and membranous valve which closes the posterior apertures of the nasal cavities, and prevents the passage of food into the nose during deglutition, are well displayed.

1550. A section of the Human head, including the septum narium, portions of the turbinated bones of the right side, the right upper jaw and teeth, and the contiguous soft parts. The section has been steeped in an acid, and dissected, to show the distribution of the filaments of the olfactory nerve, and also of some of the branches of the fifth pair which traverse and supply the organ of smell.

This preparation is described and figured in the 'Observations on Certain Parts of the Animal Œconomy,' 2nd edit., p. 250. Plates XVII. and XVIII.; and its history is thus given by Mr. Hunter:

"In the summer of 1754, being much employed in dissecting the nerves passing out of the skull, I was, of course, led to trace many of their connexions with those from the medulla spinalis; and was assisted by Dr. Smith, then pursuing his studies in London. The better to trace these nerves through the foramina of the skull, I steeped the head in a weakened acid of sea-salt till the bones were rendered soft; and that the parts might be as firm as possible, and at the same time free from any tendency to putrefaction (it being summer,) the acid was not diluted with water, but with spirit. When the bones were rendered soft, pursuing my intention, I dissected the first pair of nerves, and discovered their distribution, and having made a preparation of the parts in which they were found, I immediately had drawings made from them, with a view to have presented the account to the Royal Society, but other pursuits prevented it. Engravings were afterwards made from these drawings; and the preparation was repeatedly shown by Dr. Hunter, in his courses of anatomy, who at the same time pointed out that alteration in the mode of reasoning upon those nerves, which would naturally arise from this discovery. In this dissection I found several nerves, principally from the fifth pair, going to and lost upon the membrane of the nose; but suppose that those have nothing to do with the sense of smelling; it being more than probable, that what may be called organs of sense, have particular nerves, whose mode of action is different from that of nerves producing common sensation; and also different from one another; and that the nerves on which the peculiar functions of each of the organs of sense depend, are not supplied from different parts of the brain. The organ of sight has its peculiar nerve; so has that of hearing; and probably that of smelling likewise; and, on the same principle, we may suppose the organ of taste to have a peculiar nerve. Although these organs of sense may likewise have nerves from different parts of the brain; yet it is most probable such nerves are only for the common sensations of the part, and other purposes answered by nerves. Thus we find nerves from different origins going to the parts composing the organ of sight, which are not at all concerned in the immediate act of vision; it is also probable, although not so demonstrable, that the parts composing the ear have nerves belonging to them simply as a part of the body, and not as the organ of a particular sense: and if we carry this analogy to the nose, we shall find a nerve which we may call the peculiar nerve of that sense; and the other nerves of this part, derived from other origins, only conveying common sensation, and we may suppose only intended for the common actions of the part. This mode of reasoning is equally applicable to the organ of taste; and if the opinion of peculiar nerves going to particular organs of sense, be well founded, then the reason is evident why the nose, as a part of our body, should have nerves in common with other parts, besides its peculiar nerves; and, as the membrane of the nose is of considerable extent, and has a great deal of common sensation, we may suppose the nerves sent to this part, for that purpose, will not be few in number. It is upon this principle the fifth pair of nerves may be supposed to supply the eye and nose in common with other parts."

For the detailed description of the branches of the fifth pair, which were discovered by Mr. Hunter to pass into the nose for the purpose of endowing the organ of smell with a function different from, and superadded to, that which it derived from the olfactory nerve, we must refer the reader to the important paper above quoted, in which it will be clearly seen that Mr. Hunter was led, by observing the constancy which the nerves presented in their differences of origin and destination, to the belief that they had particular functions in relation to those differences, and that they were not alike endowed with one general or common function. "I have no doubt," he observes, "if their physiology was sufficiently known, but we should find the distribution and complication of nerves so immediately connected with their particular uses as readily to explain many of those peculiarities for which it is now so difficult to account. What naturally leads to this opinion is, the origins and number of nerves being constantly the same; and particular nerves being invariably destined for particular parts, of which the fourth and sixth pair of nerves are remarkable instances. We may therefore reasonably conclude, that to every part is allotted its particular branch; and that however complicated the distribution may be, the complication is always regular." Instead, therefore, of discouraging the anatomist who minutely investigates the disposition of the nervous system, Mr. Hunter especially dwells upon the importance of that branch of inquiry. "Whoever," he says, "discovers a new artery, vein, or lymphatic, adds little to the stock of physiological knowledge, but he who discovers a new nerve, or furnishes a more accurate description of the distribution of those already known, affords us information in those points which are most likely to lead to an accurate knowledge of the nervous system; for if we consider how various are the origins of the nerves, although all arise from the brain, and how different the circumstances attending them, we must suppose a *variety of uses* to arise out of every peculiarity of structure."

Animal Œconomy, 2nd edit., pp. 259, 260.

1551. The Human septum narium minutely injected, dried, and preserved in oil of turpentine, showing the great vascularity of the pituitary membrane covering that part, and the mode of ramification of the vessels.

1551 A. A longitudinal vertical section of the head of a Hare (*Lepus timidus*, LINN.), in which the filaments of the olfactory nerve are traced upon the septum narium, and a branch of the infraorbital division of the trigeminal nerve, or fifth pair, is seen passing into the nose, and continued to the root of the large and complicated inferior spongy bone. The parts are minutley injected, showing their respective degrees of vascularity, which is greatest on the inferior spongy bone: bristles are placed beneath the above-mentioned nerves, and into the nasal opening of the Eustachian tube. *Mus. Brookes.*

1552. A longitudinal vertical section of the head of a Leopard (*Felis Leopardus,* Linn.), showing the turbinated bones of the left side *in situ.* The extent of the nasal cavity is proportionally greater than in the Hare, the increase being principally in the superior and middle turbinated bones, while the anterior one presents a less complicated surface towards the nasal cavity. The parts are minutely injected.

1553. A longitudinal section of the side of the head of a young Lion (*Felis Leo,* Linn.), showing the ossa turbinata *in situ.*

The superior bone is of a conical form, extending along the whole of the roof of the nasal cavity, with its base opposite to the frontal sinus (which is here exposed), and its apex terminating above the anterior extremity of the inferior turbinated bone. It presents a smooth or uniform surface towards the nasal cavity, as may be seen in the preceding specimen; but the lamella forming this surface has been partially removed, showing the subjacent lamella, which is folded longitudinally: the more complicated disposition of the exterior lamella of the same bone is exhibited on the opposite side of the preparation, where the surface for the extension of the olfactory membrane is augmented by a series of deep arched folds, having their convexity upwards. The middle turbinated bone is also of a pyramidal form, its broad basis being applied to the cribriform plate of the ethmoid bone, and its apex extending between those of the other two turbinated bones, but not reaching so far forwards. The nasal or mesial surface of this bone is complicated by numerous deep furrows, two of which extend longitudinally, parallel with the superior margin of the bone, while the others radiate in an irregular manner from the lower point of attachment. The lateral surface of the bone is less complicated and extensive. The inferior and anterior turbinated bone is of an elongated form, and contracted at both extremities. Its posterior and inferior extremity is attached to the outer parietes of the nasal passage, below the middle of the middle turbinated bone; from this point it extends obliquely upwards, enlarging as it crosses the anterior extremity of the middle bone, and then diminishing in size to its anterior and superior attachment behind the external nostril: from its position, therefore, the odorous particles in inspiration must first impinge upon this bone. Its nasal surface is pretty uniform, presenting only one curved groove, parallel with, and near to, the lower margin of the bone; in this respect differing widely from the lower turbinated bone in the Hare: its exterior surface is similarly characterized. In the preparation the outer lamella has been cut away to show the subjacent fold. The whole being minutely injected, the vascularity of the pituitary membrane extended over this vast and complicated surface is well displayed. The pituitary membrane is evidently thickest and most vascular at the anterior part of the cavity, where it must receive the first impression of the external air. A portion of the pituitary membrane is reflected from the base of the middle turbinated bone, showing the fibres of the olfactory nerve spreading over it.

1554. The opposite section of the same head, in which the second lamella of the superior spongy bone has been removed, showing the arched concentric processes of the bone: a similar section has also been removed from the lower part of the base of the middle spongy bone, in which the arched processes are turned in the opposite direction. A part of the nasal gland at the anterior part of the floor of the cavity, and the commencement of the anterior palatine canal, are also shown.

1555. The intermediate section of the same head, including the septum narium, with the vascular pituitary membrane entire; through which may be seen branches of the olfactory nerve passing in a curved direction towards the thickened base of the septum.

1556. One of the inferior turbinated bones, with the pituitary membrane injected, of a Calf.

1556 A. Three sections of the inferior turbinated bone of a Horse (*Equus Caballus*, Linn.), showing the cut extremities of the veins which form the plexus subjacent to the pituitary membrane. *Presented by Jos. Swan, Esq.*

1557. A vertical section of the anterior part of the head of a large Seal (*Phoca*, Linn.), including the inferior spongy bone of the right side. The nasal surface of this bone is singularly complicated by folds, which radiate from both extremities of the bone and subdivide dichotomously upon its body. The superior turbinated bone is equally complicated in its structure, but of comparatively very small size.

1558. The inferior spongy bone of the opposite side of the same Seal, showing its exterior surface similarly complicated, but divided into two parts by a deep longitudinal furrow. It may be observed that this bone is attached by its extremities only.

1559. A vertical section of the same head, including the septum narium.

Series IV. Organ of Hearing.

"The Organ of Hearing is peculiar to certain classes of animals; the more imperfect do not appear to be endowed with this sense. Insects certainly have it, if what is related of Bees be true: however, I have not been able to discover the organ itself below Fish, where it is very conspicuous*.

"It is a specific or peculiar organ for the sensation of sounds, the organ itself answering no other known purpose, which was not the case with the three preceding.

"As the matter, or body, which is the first cause of sound is not in contact with the organ, there must be an intermediate connexion or medium between the two. This medium is not confined to any one species of matter, which circumstance we may suppose produces a variety, and therefore the organ must vary in some degree according to the medium. The air appears to be the proper medium for us, but water is the medium for Fish: however, even to us the medium is not confined to air, nor can we justly suppose that it is confined to water in Fish.

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* Many circumstances tend to prove that the manuscript Introductions to the different Series were written at an early period of the formation of the Collection. In the year 1782, Mr. Hunter stated in his account of the Organ of Hearing in Fish, read before the Royal Society, "that the class called Sepia" (the modern 'Cephalopods', and the 'Mollia' of the ancients,) "has this organ also, but somewhat differently constructed from what it is in the Fish." (*Phil. Trans.* 1782, p. 380.)

"As sound is communicated by vibration, everything that does vibrate is either capable of producing sound or of increasing it; and perhaps air has the least power of vibration of any substance or modification of matter we are acquainted with: and, from experiment, water has been found to be a much better vibrator than air.

"As this is the case, it would from thence appear, that an ear destined to hear in water need not be so nicely constructed as one in an animal whose way of life confined it to live in air, and accordingly we find them very different.

"The vibrations of the medium of sound in many animals are increased before they reach the organ of sense by outworks, called the external ear; but this is not universal, belonging only to some of those whose ears are adapted to the vibration of air, and even in them it varies considerably in the different animals that have it: besides this, there are other increasers of vibrations, such as membranes stretching across the cavity, and other apparatuses besides.

"The most simple construction of the organ of sound in any of the animals that I am yet acquainted with is that in Fish. It is composed of three canals, describing nearly a circle each, and so placed as to make a triangle. Some of these communicate with one another at their ends, others not. They all open into one cavity common to the whole.

"These canals, in this class of animals, are thin and transparent, and of a cartilaginous substance, pretty regular in size through the whole, excepting at or near to their unions, where they swell immediately into round cavities. They are placed in the bones or cartilages of the skull or head, and in canals or passages in these parts by much too wide for them, and are supported in these passages by a very fine cellular membrane. In many they project into the cavity of the skull. They appear to have no external communication whatever.

"The cavity formed by the union of the whole is pretty large; in it there is a bone of a particular shape in some, while it appears to be a chalky substance in others, as in the Skate, or Ray tribe; in all it is perfectly detached : it is very large in all the Cod tribe. Besides the bone there is water, or a fluid, in the cavity.

"The nerves are very distinct in this order of ears: it appears that they do not enter the cavity of these canals and spread upon their inner surfaces, as is generally supposed to be the case in the Human ear, but seem to be attached to the external surface only, on which they spread so as to inclose a little more of the canal.

"The next class of animals above Fish is the Tricoilia. Their organ of hearing becomes a little more complicated, having a greater variety of parts annexed to it. They have the three semicircular canals as in Fish, but they are smaller and not so long. They lie in the bones of the head, where there are very wide passages for them: they unite into one common cavity, which has a chalk in it, as in the Skate, &c.

"The additional parts in this class of animals.—From this hall, or common cavity, passes outwards to the external surface a long small bone, which is broad at its inner end or base, where it makes a part of the hall: its outer end is attached to a membrane in most of this tribe; but to a cartilage in the Turtle, which is of an oblong figure, convex externally and concave internally: this membrane is also convex on one side and concave on the other, in the same position as the cartilage. In most it is nearly in a line with the common surface of the body, as in the Lizard, Toad, Frog, &c.; but it is placed somewhat deeper in the Crocodile, which has something similar to an external ear; and it is covered in some by the common integuments or scales, as in the Turtle. This cavity has an opening into the mouth, which is very probably no more than a duct.

"The next class of animals above the Tricoilia is the Birds. Although their ear is not much more complicated than that of the Tricoilia, yet it differs from it in some degrees. There is a neatness and precision in the structure that is not to be found in the Tricoilia. The semicircular canals in the bone are small and regular, and appear to answer the purpose of these canals. If there are also the membranous canals, then they are to be considered here as only linings to the bony. The hall is smaller than in the former.

" The passage between the hall and membrane is enlarged and extended into the meditullium or cells of the bones of the head, and much more in some Birds than in others.

" The membrane of the ear is not so superficial, so that there is a canal, or a continuation of the same canal, beyond this membrane, leading to the external surface, which terminates in particular forms in different Birds, which may be called an external ear, passage, or focal [cavity].

" The communication between the hall and membrane by means of bone is similar to the former.

" There is a passage from the ear into the mouth.

" The next class of animals above the Bird is that commonly called Quadruped. Their ear is much more complicated than any of the former, having actually more parts.

" In this class the semicircular canals are similar to the former, but we have passing from the hall another or fourth canal, which is coiled upon and within itself, called cochlea.

" The tympanum is extended some way into the bones of the head; in some much more so than in others, as in the Elephant, similar to many Birds. The membrane is more internal than in the former, which, of course, makes the distance between that membrane and the external surface still greater. It is concave externally, contrary to the foregoing. The communication between the hall and membrane is by three bones* instead of one.

" The passage from the membrane outwards is of considerable length; first in the bones, then continued further by means of a chain of cartilage, making a pipe, which when got to the external surface spreads in most into various forms and length, called the external ear. But this last part is not to be found in all: it is not in any of the Whale kind, perhaps because the water is sufficient of itself; nor is it of any size in the Seal kind, perhaps because they are intended to search after their prey in the water, therefore not necessary. Nor are they to be found in many animals whose life is principally led underground, such as the Mole; and perhaps because the earth assists considerably in vibration.

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* From this passage it would appear that Mr. Hunter considered the os orbiculare as an epiphysis merely, as it has subsequently been regarded by several anatomists. See *Carlisle, Phil. Trans.* 1805, p. 201; *Blumenbach, Comp. Anat. by Lawrence,* 2nd edit., p. 241.

"Query: Does the membrane of the ear increase the sound by increasing the number of vibrations, or by increasing only the same vibration; or does it only communicate the first vibration in the air? I should be apt to suppose the first." *Hunterian manuscript Catalogue.*

SUBSERIES 1. *In Crustaceans.*

1559 A. A Hermit Crab (*Pagurus Miles*, OLIV.), prepared to show the organ of Hearing, which is composed of a simple vestibular cavity situated at the under part of the basal joint of the external antenna. The cavity is surrounded by a dense crustaceous substance, except at the internal opening, where the auditory filament of the antennal nerve penetrates it, and at the opposite side, where an elliptical opening or fenestra is left, which is closed by the acoustic membrane: the vibrations of sound affect this membrane, and are transmitted to the nerve, which is exposed on the left side. *Prepared by Mr. Owen.*

2. *In Cephalopods.*

1559 B. The head of a Cuttle-fish (*Sepia officinalis*, LINN.), prepared to show the organ of hearing. The cartilaginous cranium is dissected from below, and the auditory vestibular cavities which are excavated in the dense substance of its basis, are laid open, showing the small conical processes from their inner surface and the calcareous body which is suspended in the pulpy matter of the vestibule, and the vibrations of which affect the auditory nerves.

A portion of the cartilaginous orbit of the right side has been removed, and the optic ganglion is exhibited. A bristle is placed in the œsophagus, which in this, as in the other molluscous classes, perforates the brain; and consequently here passes through the cranium, and above the organ of hearing. *Prepared by Mr. Owen.*

3. *In Fishes.*

" Some time before I quitted my anatomical pursuits, in the year 1760, and went with the army to Bellisle, I had discovered the Organ of Hearing in fishes, and had the parts exposed and preserved in spirits. In some the canals were filled with coloured injection, which showed them to great advantage; and in others were so prepared as to fit them to be kept as dried preparations*. My researches in that and in every other part of the animal œconomy have been continued ever since that time. I am still inclined to consider whatever is uncommon in the structure of this organ in fishes as only a link in the chain of varieties displayed in its formation in different animals, descending from the most perfect to the most imperfect, in a regular progression †.

" As in this age of investigation, a hint that such an organ existed would be sufficient to excite a spirit of conjecture or inquiry, I was aware that there would not be wanting some men who, whether they only imagined the fact might be true, or really found it to be so, would be very ready to assume all the merit of the discovery to themselves. My attention was more strongly called to this point by hearing, in conversation, that some anatomists in France, Germany, and Italy had discovered the organ of hearing in fishes, and intended to publish on the subject. I therefore thought that it would be only justice to myself to deliver to the Royal Society a short account of that organ, a discovery of which I had made more than twenty years before. This account I shall reprint here, without adding anything to what I had before written; reserving a more complete examination of this subject for a larger work on the structure of animals, which I one day hope to have it in my power to publish.

" I do not intend to give a full account of this organ in any one fish, or of the varieties in different fishes, but only of the organ in general;

" * I have injected these parts in other animals both with wax and metals, which, the bone being afterward corroded in spirit of sea-salt, make elegant casts of these canals.

" † The preparations to illustrate these facts have been, ever since, shown in my collection, to both the curious of this country and foreigners. In showing whatever was new, or supposed to be new, the ears of fishes were always considered by me as one important article.

those therefore who may wish to pursue this branch of the animal œconomy will think it deficient, perhaps, in the descriptive parts. If it was a difficult task to expose this organ in fishes, I should perhaps be led to be more full in my description of it; but in fact there is nothing more easy.

" It may be proper just to observe here that the class called Sepia has the organ of hearing, though somewhat differently constructed from what it is in fishes.

" The organ of hearing in fishes is placed on the sides of the skull, or cavity which contains the brain; but the skull makes no part of it, as it does in the Quadruped and the Bird, the organ being a distinct and detached part. In some fishes, as in those of the Ray kind, the organ is wholly surrounded by the parts composing the cavity of the skull; in others it is in part within the skull or cavity which contains the brain, as in the Salmon, Cod, &c. the skull projecting laterally and forming a cavity.

" The organ of hearing in fishes appears to increase in dimensions with the animal, and nearly in the same proportion; which is not the case with the Quadruped, &c., the organs being in them nearly as large in the growing fœtus as in the adult. Neither is its structure by any degree so complicated in fishes as in all those orders of animals which may be reckoned superior, such as quadrupeds, birds, and amphibious animals; but there is a regular gradation from the first of these to fishes.

" It varies in different genera of fishes; but in all it consists of three curved tubes which unite one with another; this union forms in some only one canal, as in the Cod, Salmon, Ling, &c., and in others a tolerably large cavity, as in the Ray kind. In the Jack (*Esox Lucius*) there is an oblong bag, or blind process, which is an addition to these canals, and communicates with them at their union. In the Cod, &c. this union of the three tubes stands upon an oval cavity; and in the Jack there are two, the additional cavities in these fishes appearing to answer the same purpose with the cavity observed in the Ray or cartilaginous fishes, which is at the union of the three canals.

" The whole organ is composed of a kind of cartilaginous substance, very hard or firm in some parts, and in some fishes crusted over with a thin bony lamella to prevent it from collapsing; for as the skull does not form any part of these canals, or cavities, they must be composed of a substance capable of keeping its form.

"Each tube describes more than a semicircle; resembling in some sort what we find in most other animals, but differing in the parts being distinct from the skull*.

"Two of the semicircular canals are similar to one another, may be called a pair, and are placed perpendicularly; the third is not so long, and in some is placed horizontally, uniting, as it were, the other two at their ends or terminations. In the Skate this is somewhat different, the horizontal being united only to one of the perpendicular canals. The two semicircular canals, whose position is perpendicular, are united, forming one canal; at their other extremities they have no connexion with each other, but join the horizontal one near its entrance into the common cavity. Near the union of these canals they are swelled out into round bags, and become much larger.

"In the Ray kind all these canals terminate in one cavity; and in the Cod, in one canal, placed upon the additional cavity or cavities, in which there is a bone or bones. In some there are two bones; and in the Jack, which has two cavities, we find in one of them two bones, and in the other one; in the Ray there is only a chalky substance†.

"In some fishes the external communication, or meatus, enters at the union of the two perpendicular canals; which is the case with all the Ray kind, the external orifice being small, and placed on the upper flat surface of the head; but it is not every genus or species of fishes that have the external opening.

"The nerves of the ear pass outwards from the brain, and appear to terminate at once on the external surface of the enlarged part of the semicircular tubes above described. They do not appear to pass through these tubes so as to get on the inside, as is supposed to be the case in

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"* The Turtle and the Crocodile have a structure somewhat similar to this; and the intention is the same, for their skulls make no part of the organ.

"† This chalky substance is also found in the ears of amphibious animals.

quadrupeds; I should therefore very much suspect that the lining of the tubes in the quadruped is not nerve, but a kind of internal periosteum.

"As it is evident that fishes possess the organ of hearing, it becomes unnecessary to make or relate any experiment made with living fishes, which only tends to prove this fact; but I will mention one experiment to show that sounds affect them much, and is one of their guards, as it is in other animals. In the year 1762, when I was in Portugal, I observed in a nobleman's garden near Lisbon a small fish-pond full of different kinds of fish. The bottom was level with the ground, the pond having been made by forming a bank all round, and had a shrubbery close to it. Whilst I lay on the bank, observing the fish swimming about, I desired a gentleman who was with me to take a loaded gun and fire it from behind the shrubs. The reason for desiring him to go behind the shrubs was, that there might not be the least reflection of light. The moment the report was made, the fish seemed to be all of one mind, for they vanished instantaneously, raising a cloud of mud from the bottom. In about five minutes afterwards they began to appear, and were seen swimming about as before." *Animal Œconomy*, 2nd edit., p. 81.

Mr. Hunter has left fifteen preparations of the Organ of Hearing in Fishes, forming the present subseries: of these preparations, eight are taken from the osseous, and seven from the higher organized cartilaginous Fishes. The organ is first exhibited in its simple form and in its natural position, and is then traced through the progressive degrees of complication to which it attains in this class.

1560. A section of the cranium of a Cod-fish (*Gadus Morrhua*, Linn.), including the organ of hearing. The parts composing this organ are the vestibule, the vestibular sacculus with its contained stone, and the semicircular canals. These are lodged in large depressions on the inner side of the lateral walls of the cranium, and are not wholly inclosed within the substance of the parietes; but the semicircular canals are confined to their situations by processes of bone passing through their arches. The labyrinth is proportionally of very large size, to compensate for the absence of the external ear and other accessory parts of the organ which will be seen in the higher vertebrate classes; and probably also in relation to the small development of the nervous centres to which the impressions of the senses are referred. The semicircular canals are injected, and the union of the internal extremities of the two vertical canals is shown. The cartilaginous and transparent parietes of the sacculus containing the dense calcareous body or stone (*lapillus, otolithus,*) is preserved entire. The osseous cavity containing the sacculus communicates by a wide opening with that which lodges the vestibule and semicircular canals.

1561. A similar preparation from the Cod, in which the sacculus is laid open, and the stone exposed: it is of a flattened elliptical form, convex towards the lower parietes of the sac, and concave on the opposite side, which is marked with small transverse furrows extending from a middle longitudinal line. See Plate XXXV. fig. 1.

1562. The organ of hearing of a Cod, in which the two branches of the auditory nerve distributed to the ampullæ are shown; the semicircular canals are not injected in this preparation. The sacculus containing the stone, to which the greater part of the olfactory nerve is distributed, is preserved entire.

1563. The right cartilaginous acoustic labyrinth of a Cod, removed from the head, injected and preserved entire, showing the great width of the united portions of the two vertical canals, the tubular form of the vestibule, and the large size of the 'sacculus vestibuli'.

1564. The left cartilaginous acoustic labyrinth of a Cod, removed from the head: the semicircular canals are injected, which shows in some parts the thickness of their cartilaginous parietes; the sacculus is laid open, and the calcareous body or otolithe removed, showing the extreme thinness of its walls as compared with those of the semicircular canals.

1565. The right and left cartilaginous labyrinths of a Cod. In one the sacculus vestibuli is destroyed, in the other it is entire and contains the stone; in both the semicircular canals are injected.

1566. A similar preparation, with the semicircular canals uninjected, showing the relative size of the horizontal and vertical canals; the former is smaller than the two latter, which are of nearly equal size.

1567. The cartilaginous labyrinth of the ear of a Pike (*Esox Lucius,* Linn.), showing the accessory sacculus of the vestibule; but the two small otolithes* which were lodged in it are not preserved. They are figured in Plate XXXV. *n, p, q, s,* together with the larger otolithe contained in the ordinary sacculus vestibuli, *o, r.*

1568. Two sections of the head of a Sturgeon (*Acipenser Sturio,* Linn.): the upper one includes the whole of the membranous acoustic labyrinth, and shows the distribution of the filaments of the portio mollis, or auditory nerve, upon the vestibule and sacculus. The lower portion exhibits the distribution of filaments of the same nerve upon the ampullæ of the semicircular canals. It may be observed that the semicircular canals are here inclosed in cavities of a corresponding figure, excavated in the cartilaginous parietes of the skull; but that the vestibule is lodged in a depression at the side of the cranial cavity.

1569. A section of the head of a Skate (*Raia Batis,* Linn.), showing the acoustic labyrinth *in situ.* Bristles are passed along some of the semicircular canals, and from the vestibule through the canal which leads to the external auditory orifice.

1570. Another section of the head of a Skate, in which the labyrinth of the left ear is filled with dark-coloured injection, and exposed *in situ.* On one side of this beautiful preparation a part of the cranial cavity is shown, which now no longer communicates with the cavity of the organ of hearing, except by means of the foramen giving passage to the auditory nerve. This nerve is of large size; it is seen to divide on entering the labyrinth into two branches, of which the larger is distributed to the vestibule and the ampulla of the posterior vertical canal, while the smaller branch goes to the ampullæ of the horizontal and anterior vertical canals. The sacculus vestibuli is of large size, and contains a cretaceous substance, or otolithe, of the consistence of starch : a denser substance is here perhaps unnecessary, since the auditory vibrations are received by a spiral canal leading to the fenestra ovalis from a small orifice in the external integument, through which, in the preparation, a bristle is placed.

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* Though these bodies are analogous in function to the tympanic ossicles of the air-breathing Vertebrata, in as much as they aid in conveying the vibrations of sound to the sensitive part of the organ of hearing, yet they are not the homologues of the ossicula, for they exist in a more or less rudimental condition in the labyrinth of the ears of the most highly organized animals: the structure of the otolithes resembles, indeed, that of shell rather than bone.

1571. The organ of hearing of a Skate, removed from the head, showing the terminations and relative sizes of the semicircular canals, the long tubular vestibule, and the large and small sacculus vestibuli. The meatus auditorius, continued from the vestibule, is preserved, and a bristle is placed in the external orifice. The entire labyrinth is filled with dark-coloured injection.

1572. A similar preparation, in which the labyrinth is injected with size and vermilion.

1573. The ampulla of one of the semicircular canals and part of the vestibule of a Skate, showing the abrupt termination of the portio mollis upon the ampulla, which is laid open and the termination of the nerve exposed.

1574. A section of the head of a Shark (*Galeus communis*, Cuv.), including the cranial and auditory cavities, which, in this highly organized fish, are entirely distinct, the several complex parts of the labyrinth being wholly contained, in corresponding excavations, in the cartilaginous parietes of the cranium. These cavities are laid open so as to expose portions of the semicircular canals on one side, and the entire labyrinth on the other. The anterior perpendicular canal is the smallest, the posterior one the largest. Their diameter is much less than that of the cartilaginous canals in which they are lodged, the interspace being filled with a serous perilymph. The sacculus vestibuli contains a whitish opake mucus, of less density or consistency than that in the Skate, which effervesces slightly with acid, showing that it contains a small proportion of carbonate of lime, and forms a rudiment of the otolithe of the bony fishes.

In Reptiles.

1575. The head of a Bull-frog (*Rana pipiens,* Linn.), showing the free and wide external communication, or 'meatus', of the organ of hearing, and the thin semitransparent vibratile membrane, or drum of the ear, which is stretched across the entrance of the meatus, and is adapted to respond to the impulse of sound conveyed through air. The cavity of the 'tympanum' is laid open on the left side from below, showing the long slender bone ('*columella*' or '*ossiculum auditus*') which forms the medium of communication between the 'membrana tympani' and the labyrinth, or internal ear. The wide vertical passage, or 'Eustachian tube,' by which the cavity of the tympanum communicates with the fauces, is also laid open on the left side, but is seen entire on the right. This communication preserves the equilibrium between the air in the cavity of the tympanum and the atmosphere without; and an equable pressure is consequently sustained by the membrana tympani under every barometrical variation. It may be observed, that the extent and freedom of the Eustachian passage are in relation to the size and exposed condition of the tympanic membrane, and perhaps also to its form, which is convex externally, and therefore the more liable to be affected by undue pressure from without, being only supported behind at a small part of its superficies.

1576. The head of an Iguana (*Iguana tuberculata,* Linn.), in which the organ of hearing is dissected on the right side. The labyrinth, which is now incased in a dense vibratile bone, the 'os petrosum', is here partially exposed. The posterior vertical cartilaginous semicircular canal, and its oval ampulla at the extremity which joins the anterior vertical canal, are clearly exhibited: bristles are placed in the two extremities of the horizontal canal, and in the external extremity of the anterior vertical canal. The small cretaceous rudimental otolithe may be observed in the sacculus vestibuli. The cavity of the tympanum is laid open from above; and the ossicle of communication is seen extending from the foramen ovale to the drum of the ear. This membrane is partially protected by its oblique position, and by a rising or fold of the external teguments at the posterior part of its circumference. On the left side the commencement of the Eustachian passage is laid open from below, showing that it is relatively narrower, and its course more oblique than in the Frog.

1577. A portion of the head of a young Crocodile (*Crocodilus acutus*, Cuv.), in which the organ of hearing is exposed from behind on both sides.

In this aquatic Reptile the membrana tympani is lodged at the bottom of a deep fissure, and is protected from external injury or pressure by an opercular flap of the common integument, which is adapted to a smaller fold below, and accurately closes the passage from above. The drum of the ear is stretched across the tympanic orifice in a plane slightly inclined downwards and outwards, so as to be adapted to the special reception of sounds coming from above, and also to the protection of the overhanging flap. The long ossiculum auditûs is shown extending obliquely downwards from the membrana tympani to the foramen ovale; its outer extremity is expanded and cartilaginous, and the membrane is thickened at the place of its attachment. The Eustachian tube is shown on the right side, extending obliquely downwards and inwards to terminate by an orifice common to both passages, in the posterior part of the nasal passage.

1578. A corresponding section of the head of a Turtle (*Chelonia Mydas*, Linn.), in which the organ of hearing is displayed on both sides. The membrana tympani is covered externally by the cutis and one of the horny epidermic scales*; these have been raised on the right side, so as to show the oblong, convex form of the membrane: the two extremities of the long ossiculum extending from the membrane to the internal ear are exposed from above, and bristles are placed beneath them. The cartilaginous labyrinth or internal ear of the same side is shown. The semicircular canals are left in the corresponding cavities of the petrous bone. The vestibule is carefully displayed, together with a part of the acoustic nerve expanding upon it; the cretaceous bodies in the sacculus vestibuli may be observed through its transparent parietes. On the right side, the bone surrounding the cartilaginous semicircular canals has been entirely removed, showing their relative position, the union of the internal extremities of the two vertical canals, and the ampulla at the commencement of each. The vestibular sac is laid open to show the cretaceous otolithes within. The long, winding, and narrow Eustachian passage is exposed through its whole course on the left side; a bristle is placed in the nasal orifice of the opposite passage, showing the wide interval which separates them.

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* The second scale counting upwards from the articulation of the lower jaw.

1579. A section of the head of a Turtle, in which the cavity of the tympanum and the whole length of the tympanic ossicle are exposed; together with the convex membrana tympani, and the commencement of the Eustachian tube: a part of the labyrinth is also displayed, showing the membrane closing the fenestra ovalis, the entrance and division of the acoustic nerve, and the communication of the semicircular canals with the vestibule. The preparation having been minutely injected, shows the vascularity of the cartilaginous parts of the internal ear.

1580. A section of the same head, including the opposite ear. The strong and thick drum of the ear hangs suspended by the long ossicle. The vestibule is laid open, showing the thick membrane of the fenestra ovalis attached to the opposite extremity of the ossicle, which forms the medium of communication between the two membranes. The terminations of the semicircular canals are also shown, and their vascularity is well displayed.

5. *In Birds.*

1581. A section of the head of the Horn-Owl (*Otus aurita*, Cuv.), showing the organ of hearing of the right side. The membrana tympani is lodged, in this tribe of Birds, at the bottom of a wide but moderately deep external meatus, which is guarded by an anterior fold of integument, and further provided with a well-developed auricular circle of feathers, which together fulfil the functions of an external concha. The drum of the ear is very thin and transparent; its vibrations are conveyed to the labyrinth by a single ossiculum, as in Reptiles. The membrane closing the foramen ovale, to which the basis of the columella is attached, the vestibule, and the three semicircular canals, are shown; the two smaller and external canals are laid open where they open into each other in the middle of their course. Bristles are placed in both Eustachian tubes, which communicate together at their nasal terminations, as in the Crocodile.

6. *In Mammals.*

Of the preparations illustrative of the organ of hearing in this Class, not less than seventeen are taken from the Cetaceous Order, affording a striking example of the extent to which the researches of the Founder were carried in those departments of comparative anatomy on which he has published his observations. Those which relate to the organ of hearing in the Whale tribe are thus recorded in the Philosophical Transactions.

"The ear is constructed much upon the same principle as in the quadruped; but as it differs in several respects, which it is necessary to particularize to convey a perfect idea of it, the whole should be described. As this would exceed the limits of this paper, I shall content myself with a general description, taking notice of those material points in which it differs from that of the quadruped.

"This organ consists of the same parts as in the quadruped; an external opening, with a membrana tympani, an Eustachian tube, a tympanum with its processes, and the small bones. There is no external projection forming a funnel, but merely an external opening. We can easily assign a reason why there should be no projecting ear, as it would interfere with progressive motion; but the reason why it is not formed as in birds is not so evident; whether the percussions of water could be collected into one point, as air, I cannot say. The tympanum is constructed with irregularities, so much like those of an external ear, that I could suppose it to have a similar effect.

"The external opening begins by a small hole, scarcely perceptible, situated on the side of the head a little behind the eye. It is much longer than in other animals, in consequence of the size of the head being so much increased beyond the cavity that contains the brain. It passes in a serpentine course, at first horizontally, then downwards, and afterwards horizontally again to the membrana tympani, where it terminates. In its whole length it is composed of different cartilages, which are irregular, and united together by cellular membrane, so as to admit of motion, and probably of lengthening or shortening, as the animal is more or less fat.

"The bony part of the organ is not so much inclosed in the bones of the skull as in the quadruped, consisting commonly of a distinct bone or bones, closely attached to the skull, but in general readily to be separated from it ; yet in some it sends off, from the posterior part, processes which unite with the skull. It varies in its shape, and is composed of the immediate organ and the tympanum.

"The immediate organ is, in point of situation to that of the tympanum, superior and internal, as in the quadruped. The tympanum is open at the anterior end, where the Eustachian tube begins.

"The Eustachian tube opens on the outside of the upper part of the fauces ; in some higher in the nose than others ; highest, I believe, in the Porpesse. From the cavity of the tympanum, where it is rather largest, it passes forwards and inwards, and near its termination appears very much fasciculated, as if glandular.

"The Eustachian tube and tympanum communicate with several sinuses, which passing in various directions surround the bone of the ear. Some of these are cellular, similar to the cells of the mastoid process in the human subject, although not bony. There is a portion of this cellular structure of a particular kind, being white, ligamentous, and each part rather rounded than having flat sides*. One of the sinuses passing out of the tympanum close to the membrana tympani, goes a little way in the same direction, and communicates with a number of cells.

"The whole function of the Eustachian tube is perhaps not known ; but it is evidently a duct from the cavity of the ear, or a passage for the mucus of these parts ; the external opening having a particular form would incline us to believe that something was conveyed to the tympanum.

"The bony part of the organ is very hard and brittle, rendering it even difficult to be cut with a saw without its chipping into pieces. That part which contains the immediate organ is by much the hardest, and has a very small portion of animal substance in it; for when steeped in an acid, what remains is very soft, almost like a jelly, and laminated. (See No. 202.) The bone is not only harder in its substance, but there is on the whole

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" * These communications with the Eustachian tube may be compared to a large bag on the basis of the skull of the Horse and Ass, which is a lateral swell of the membranous part of the tube, and when distended will contain nearly a quart.

more solid bone than in the corresponding parts of quadrupeds, it being thick and massy.

"The part containing the tympanum is a thin bone, coiled upon itself, attached by one end to the portion which contains the organ; and this attachment in some is by close contact only, as in the Narwhale; in others, the bones run into one another, as in the Bottle-nose and Piked Whales.

"The concave side of the tympanum is turned towards the organ, its two edges being close to it; the outer is irregular, and in many only in contact, as in the Porpesse: while in others the union is by bony continuity, as in the Bottle-nose Whale, leaving a passage on which the membrana tympani is stretched, and another opening, which is the communication with the sinuses.

"The surface of the bone containing the immediate organ opposite to the mouth of the tympanum is very irregular, having a number of eminences and cavities. The cavity of the tympanum is lined with a membrane, which also covers the small bones with their muscles and appears to have a thin cuticle. This membrane renders the bones, muscles, tendons, &c. very obscure, which are seen distinctly when that is removed. It appears to be a continuation of the periosteum, and the only uniting substance between the small bones. Besides the general lining, there is a plexus of vessels which is thin and rather broad, and attached by one edge, the rest being loose in the cavity of the tympanum, somewhat like the plexus choroides in the ventricles of the brain. The cavity we may suppose intended to increase sound, probably by the vibration of the bone; and from its particular formation we can easily conceive that the vibrations are conducted or reflected towards the immediate organ, it being in some degree a substitute for the external ear.

"The external opening being smaller than in any animals of the same size, the membrana tympani is nearly in the same proportion. In the Bottle-nose Whale, the Grampus, and Porpesse it is smooth and concave externally, but of a particular construction on the inner surface; for a tendinous process passes from it towards the malleus, converging as it proceeds from the membrane, and becoming thinner to its insertion into that bone. I could not discover whether it had any muscular fibres which could affect the action of the malleus. In the Piked Whale, the termination of the external opening, instead of being smooth and concave, is projecting, and returns back into the meatus for above an inch in length; is firm in texture, with thick coats; is hollow on its inside, and its mouth communicating with the tympanum; one side being fixed to the malleus similar to the tendinous process which goes from the inside of the membrana tympani in the others.

" A little way within the membrana tympani, are placed the small bones, which are three in number, as in the Quadruped, malleus, incus, and stapes; but in the Bottle-nose Whale there is a fourth, placed on the tendon of the stapedæus muscle. These bones are, as it were, suspended between the bone of the tympanum and that of the immediate organ.

" The malleus has two attachments, besides that with the incus; one close to the bone of the tympanum, which in the Porpesse is only by contact, but in others by a bony union; the other attachment is formed by the tendon above described being united to the inner surface of the membrana tympani. Its base articulates with the incus.

" The incus is attached by a small process to the tympanum, and is suspended between the malleus and stapes. The process by which it articulates with the stapes is bent towards that bone.

" The stapes stands on the vestibulum by a broad oval base. In many of this tribe the opening from side to side of the stapes is so small as hardly to give the idea of a stirrup.

" The muscles which move these bones are two in number, and tolerably strong. One arises from that projecting part of the tympanum which goes to form the Eustachian tube, and running backwards is inserted into a small depression on the anterior part of the malleus. The use of this muscle seems to be to tighten the membrana tympani; but in those which have the malleus anchylosed with the tympanum we can hardly conjecture its use. The other has its origin from the inner surface of the tympanum, and passing backwards is inserted into the stapes by a tendon, in which I found a bone in the large Bottle-nose. This muscle gives the stapes a lateral motion. What particular use in hearing may be produced by the action of these muscles I will not pretend to say; but we must suppose, whatever motion is given to the bones, must terminate in the movement of the stapes.

"The immediate organ of hearing is contained in a round, bony process, and consists of the cochlea and semicircular canals, which somewhat resemble the quadruped; but, besides the two spiral turns of the cochlea, there is a third, which makes a ridge within that continued from the foramen rotundum, and follows the turns of the canal.

"The cochlea is much larger, when compared with the semicircular canals, than in the human species and quadruped.

"We may reckon two passages into the immediate organ of hearing, the foramen rotundum and foramen ovale. They are at a greater distance than in the quadruped. The foramen rotundum is placed much more on the outer surface of the bone, and not in the cavity of the bony tympanum, but may be said to communicate with the surrounding cellular part of the tympanum. The foramen rotundum, which is the beginning of one of these turns, appears to be only one end of a transverse groove, which is afterwards closed in the middle, forming a canal with the two ends open; so that this foramen appears to have two beginnings; but the other opening is probably only a passage for blood-vessels going to the cochlea.

"From this foramen begins the inner turn of the cochlea, which is the largest, especially at its beginning; the other begins from the vestibulum. The cochlea is a spiral canal coiled within itself, and divided into two by a thin spiral bony plate, which is completed in the recent subject, and forms two perfect canals.

"In the recent subject, the foramen rotundum is lined with the membrane of the tympanum, which terminates in a blind end, forming a kind of membrana cochleæ. The other opening, in the recent subject, communicates with the spiral turn, beyond the membranous termination of the foramen rotundum.

"The foramen ovale has a little projection inwards all round, on which the stapes stands: within this is the vestibulum, which is common to the other spiral turn of the cochlea, and the semicircular canals; this canal of the cochlea passes out first in a direction contrary to its general course, but soon makes a turn into the spiral. It is round, and not merely a division of the cochlea into two by a septum, but has a membrane of its own, which is attached to the thin bony plate and lines that part of the cochlea in such a manner as to retain its structure when the bone is removed. The cochlea in some completes one turn and a half; in others, more. It is not a spiral on a plane, or cylinder, but on a cone.

"I have already observed, that by looking in at the foramen rotundum, we see two small ridges; the uppermost is the swell of the canal from the vestibulum just described; the lower ridge, which is also a canal, may be observed just to pass along the foramen belonging to this canal, close to the septum between the two; a circumstance, I believe, peculiar to this tribe. Its beginning is close to the vestibulum, but does not open from it, and passes along the first-described spiral turn to its apex: when open, it appears to be a canal full of small perforations, probably the passages of the branches from the auditory nerve.

"This bony process has several perforations in it; one of them large, for the passage of the seventh pair of nerves. The size of the portio mollis, before its entrance into the organ, is very large, and bears no proportion to that which enters. The passage for this nerve is very wide, and seems to have an irregular, blind, conical, and somewhat spiral, termination; its being spiral arises from the closeness to the point of the cochlea.

"In the terminating part there are a number of perforations into the cochlea, and one into the semicircular canals*, which afford a passage to the different divisions of the auditory nerve. There is a considerable foramen in its anterior side near the bottom, for the passage of the portio dura, and which is continued backward to the cavity of the tympanum near the stapes, and immerges near the posterior and upper part of this bone." *Hunter, On Whales, Phil. Trans.* 1787, p. 430.

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* Cuvier, in correcting the error into which Camper had fallen when he denied the existence of the semicircular canals in the Whale, appears to have overlooked the fact that they had previously been discovered in the Cetacea by Hunter. And it is because they do not present any difference of note as compared with other Mammalia, (except in their relative volume to other parts of the labyrinth, which Hunter is careful to point out,) that they are not described by him with the same minute detail as the cochlea and other parts of the organ. It may also be observed that the extent of his researches on this subject saved him from the error into which Cuvier has fallen of ascribing to the Cetacea a structure of the cochlea which is peculiar to a small part only of the order. (See *Leçons d'Anat. Comp.*, tom. iii. p. 467. *Ossem. fossiles*, v. Pt. 1. p. 300.)

1582. A section of the head of a Porpesse (*Phocæna communis,* Cuv.), showing the organ of hearing of the left side. The narrow winding passage forming the meatus auditorius externus is traced and laid open from its small external orifice to the tympanum. That cavity is also laid open, showing the thick membrana tympani, the triangular ligament connecting it to the malleus, the membrane lining the cavity, and the tympanic plexus of vessels. Bristles are passed from the cavity of the tympanum into the Eustachian tube, and also into some of the sinuses described by Mr. Hunter in the preceding quotation. These sinuses may be observed in the present example to be the nidus of an Entozoon (*Strongylus minor,* Kuhn.), which infests them in astonishing numbers. The Eustachian tube, into which the largest bristle is passed, is laid open through the greater part of its extent, showing the glandular structure of its dilated extremity. A portion of the bony parietes of the skull is removed to show the dense bony chamber of the tympanum, and that containing the internal ear; the canal through which the portio mollis passes from the cranium to the labyrinth is laid open, and the large size of the nerve at this part is worthy of observation.

1583. The meatus auditorius externus of a Dolphin (*Delphinus Tursio,* Fabr.).

1584. The organ of hearing of the Bottle-nose Whale (*Delphinus* (*Hyperoodon*) *Dalei,* Cuv.). The meatus auditorius externus is laid open through its whole length; it is very narrow at its commencement, where its lining membrane continues smooth for about an inch and a half; then the passage dilates a little, and the orifices of many follicles analogous to the ceruminous glands may be observed in it; beyond this part the inner surface is longitudinally plicated, and afterwards is surrounded by a fibro-cartilaginous sheath, which gradually expands to within an inch of the membrana tympani, where the cartilage terminates; beyond this part the passage again contracts to its termination, just before which it winds round a smooth mammilloid projection of the tympanic bone. The cavity of the tympanum is laid open, showing its delicate lining membrane, the large tympanic plexus of vessels, and the strong triangular ligament which connects the membrana tympani with the malleus. The dense petrous bone containing the labyrinth, or the ‘ immediate organ’, is preserved entire.

1585. A section of the organ of hearing of the same Whale, including the termination of the Eustachian tube and part of the nasal passage ; their communication is indicated by the passage of a bristle into the Eustachian tube, which is laid open to show its singularly reticulated structure.

1586. A similar section, including the “termination of the Eustachian tube in a Whale.” *Label*, 1817.

1587. A section of the head of a Porpesse, showing the termination of the Eustachian tube, and its communication with the sinuses described in No. 1582, which are here similarly infested with Entozoa.

1588. A section of the head of a Porpesse, showing the dense bones containing the tympanum and labyrinth *in situ.* This preparation has been minutely injected and steeped in an acid: the osseous parts of the organ of hearing may be distinguished by their whiter and more earthy appearance from the portions of the cranium and lower jaw which are also preserved. The meatus auditorius is exposed through the whole of its course ; a bristle is placed in its commencement. Bristles are also placed in the Eustachian tube and in the meatus auditorius internus, through which the acoustic nerve may be observed to pass.

1589. A portion of the lining membrane of the tympanum, with the attached plexus of vessels, injected, from the opposite ear of the same Porpesse.

1590. The tympanic and petrous bones of a Porpesse, with the cavity of the tympanum laid open, and the ossicula auditus, their ligaments and muscles, displayed *in situ.* The strong triangular ligament which passes from the membrana tympani to the malleus is conspicuous from its glistening fibres. The ‘ tensor tympani’, which passes in the opposite direction to be inserted into the short process of the malleus, presents a similar aspect. The stapes is almost hidden in the fossa leading to the fenestra ovalis, but may be distinguished by the 'stapideus' muscle, the fibres of which converge to be attached to its apex. The petrous bone is left entire, showing the meatus auditorius internus and the foramen rotundum, which is traversed by a thin transverse septum which divides the 'scala cochleæ' from an intermediate passage containing the vessels of the cochlea.

1591. A similar preparation, in which the structure of the cochlea is displayed in addition to the parts shown in the preceding specimen. The membrane lining the 'scala vestibuli' is left entire, showing that it is a complete canal, or cylinder, attached at one side to the spiral septum: the 'scala tympani' is laid open from its commencement at the 'fenestra rotunda'. Its peculiar course is well shown; it first rises from the vestibule making an elegant curve outwards before it begins to form the usual spiral turns, which are in a contrary direction, and extend to two and a half in number.

1592. The tympanum and labyrinth of the opposite ear of the same Porpesse, similarly prepared; but the beginning of the vascular canal at the foramen rotundum, which is continued between the two scalæ, is here better displayed; it is seen at the concavity of the first curve of the scala vestibuli, the lining membrane of which is left entire: the scala cochleæ is laid open.

1593. The corresponding parts of a Dolphin (*Delphinus Tursio*, Fabr.), in which the tympanic ossicles and their muscles are exposed, and the structure of the cochlea displayed; the branches of the acoustic nerve are here traced to the lamina spiralis. The structure of the different parts corresponds to that in the Porpesse, but they are seen to greater advantage from their larger size.

1594. The labyrinth, or internal ear, of the same species, showing the semicircular canals: the osseous cavities of these parts are laid open; the place of the membranous canals is occupied by black threads; their relative position resembles that in other Mammalia, but their magnitude in proportion to the cochlea is much less.

1595. A portion of the tympanic bone, with the ossicula auditus, of the Bottle-nose Whale (*Hyperoodon Dalei*, Cuv.), steeped in an acid, and prepared to show the bony union of the malleus to the tympanum. The stapes is small, but dense and massive.

1596. The tympanic bone, with part of the fatty substance in which it is imbedded, of the Piked Whale (*Balæna Boops*, Linn.). This substance has been removed from the outer side of the bone: the opposite involuted part is covered by the dense membrane, which is continued into the tympanum to form the lining of that cavity. At the upper part of the elongated fissure, leading to the cavity of the tympanum, the termination of the meatus auditorius, and the convex pouch of the membrana tympani, which projects into the meatus, are preserved. A bristle is passed round the handle of the malleus, to which the tympanic ligament is attached.

1597. The bed of fatty ligamentous substance in which the tympanic bone is lodged, from the same Whale.

1598. A section of the tympanic bone of a Whalebone Whale (*Balæna Mysticetus*, Linn.), which has been steeped in an acid, and cut through, to show its dense structure. The present preparation is a slender projection or process of the os tympani; the dense structure of the petrous bone is shown in the preparations No. 202, 203.

1598 a. A small portion of the tympanum of a young Whalebone Whale, including the membrana tympani and the ligament which attaches it to the malleus. The membrana, or ear-drum, is attached in an elliptical form to the concavity of the tympanic bone; and opposite to the meatus auditorius it bulges outwards in the form of a pouch, the convexity of which projects into that passage. The triangular ligament which passes to the malleus is attached to the middle of the plane part of the membrana tympani and to one side of the projecting pouch.

The structure of the ear-drum is well displayed: the outer layer of membrane, which is continued from the lining membrane of the meatus externus, is reflected from the upper part of the pouch; the inner layer of membrane, which is in like manner continued from the lining of the tympanum, is removed from the upper part of both the plane and convex parts; the fibrous structure of the intermediate or proper layer of the membrana tympani is very conspicuous. *Prepared by Mr. Clift, F.R.S.*

1598 B. The petrous bone and ossicula auditûs of the same animal. The articulation of the malleus and incus is readily seen; that between the incus and stapes is indicated by a portion of black bristle, immediately below which the insertion of the stapideus muscle takes place: the single muscle of the malleus is also shown.

The fenestra ovalis is situated in the depression containing the stapes, and is, as usual, closed by its basis. The fenestra rotunda may be observed, also lodged in a depression; it is closed by a membrane, and seems not to be divided as in the Dolphins. Both the scalæ of the cochlea and the intervening lamina spiralis are exposed in part of their gyrations: the acoustic nerve is preserved where it enters the meatus auditorius internus. *Prepared by Mr. Clift, F.R.S.*

The description of this preparation in the *Philosophical Transactions* (vol. cii. 1812, p. 83. Pl. I. and II.), in which Mr. Hunter's account of the connexions of the membrana tympani in the *Balænæ* is considered to be erroneous, and in which it is stated that there is no connexion whatever between the membrana tympani and the malleus, is undoubtedly incorrect: the accuracy of the Hunterian description is, on the contrary, confirmed by this dissection.

1599. The cranium of a Jerboa (*Dipus Sagitta*, Linn.), showing the large globular tympanic cavities: on the right side the membrana tympani is preserved, with the attachment of the malleus; on the left side the tympanum is laid open and the ossicula auditus and the cochlea exposed; the latter makes three entire turns and a half.

1600. A section of the cranium of a young Lion (*Felis Leo*, Linn.), including the organ of hearing of the left side. A part of the meatus is preserved with the membrana tympani, and the cavity of the tympanum is laid open, showing the convexity of the membrane turned towards it, as in most Mammalia.

1601. A horizontal section of part of the Human head, including the organ of hearing of the right side. The *meatus auditorius externus* is laid open through its whole extent, showing its direction and structure, and the oblique position of the membrana tympani. The cavity of the tympanum is laid open, and the ossicula auditus are preserved in their natural positions: the large bristle is placed between the malleus and the long leg of the incus; the small one passes through the hollow of the stapes and behind the stapideus muscle. The section also exposes part of the vestibular cavity, leaving entire the membrane of the fenestra ovalis against which the base of the stapes is applied. Portions of the semicircular canals are laid open, together with the mastoid cells.

1602. A vertical section of the same head, showing the organ of hearing of the left side. In this section the shape and position of the ear-drum are better displayed; the attachment of the stapes to the fenestra ovalis is seen in another point of view. The communication of one of the semicircular canals with the vestibule is shown by the passage of a bristle.

1603. The labyrinth of the Human ear, showing the structure of the cochlea, and the relative sizes and positions of the three semicircular canals.

1604. A section of the basis of the Human head, showing the cartilaginous portions and expanded nasal orifices of the Eustachian tubes.

7. *External Ears.*

1605. A longitudinal section of the head of the Australian Scincus (*Tiliqua scincoides*, Cuv.), showing the membrana tympani sunk below the surface of the head at the bottom of a large meatus auditorius externus, which is slightly protected at its anterior part by a fold of the integument which is covered with minute scales.

1606. A longitudinal section of the head of a young Crocodile, showing the convex membrana tympani lodged within a broad but shallow meatus externus: the larger opercular flap by which it is protected, and which descends from the upper part of the meatus, has been cut off; the smaller inferior fold remains.

1607. A longitudinal section of the head of a Tortoise (*Testudo Græca*, Linn.), from which the horny scales have been removed, showing the membrana tympani; which is, in the natural state, covered by the scales, but is not lodged within a meatus externus. A bristle is inserted in the Eustachian tube.

1608. The anterior part of a Mole (*Talpa Europæa*, Linn.), from which the hair has been removed to show the external orifices of the ears and eyes, in both of which bristles are placed.

1609. The anterior part of a Mole, with the fur left on, showing the entrance to the meatus auditorius externus unprovided with a projecting concha, or external ear, which would be an impediment in the act of burrowing, and an unnecessary appendage, for the reason assigned by the Founder in the Introduction to this series. It may be observed that in the Mole, which lives habitually in the soil, the meatus is defended by the smallness of the external opening.

1610. A portion of the integument of the Ratel (*Ratelus mellivorus*, Benn.), including the external orifice of the meatus auditorius, which is here suddenly expanded, and the cavity provided with slightly elevated margins, and some internal folds, or risings; but there is no projecting external concha in this animal, which, as it burrows for temporary purposes, has the apparatus for collecting the rays of sound only so far developed as was compatible with subterraneous progression.

1611. A section of the integument of the head of a Seal (*Otaria*, Peron), showing the small pointed external ear characteristic of Peron's subgenus of the Linnæan 'Phoca'. The size, shape, and position of the concha is such as to present no impediment in swimming. The meatus auditorius is long and tortuous, and its parietes are supported by a series of oblong fibro-cartilages, which are moveably connected together.

1612. A portion of the skin of the head, with the concha or auricle, of the Slender Lemur (*Loris gracilis*, Geoff.). It is large, naked, and prominent, and is provided with two broad transverse processes above the tragus.

1613. The auricle of a small quadruped. It is large, thin, and semitransparent, and is characterized by the large size and horizontal position of the antitragus, which is bent from side to side with the concavity looking upwards, and curves downwards over the orifice of the meatus externus immediately anterior to the tragus.

1614. The auricle injected, of a Rabbit (*Lepus Cuniculus*, LINN.).

1615. The fibro-cartilages of the auricle of a Fallow-Deer (*Cervus Dama*, LINN.). They consist of two smaller portions, articulated to the base of the auricle, in addition to the large expanded plate, or concha, to which the auricle owes its form.

1616. The two smaller fibro-cartilages and the base of the larger cartilage of the opposite auricle of the same Deer.

1617. The fibro-cartilages of the auricle of a Horse (*Equus Caballus*, LINN.).

1618. The corresponding parts of the Ass (*Equus Asinus*, LINN.).

1618 A. The fibro-cartilage of the expanded pendent portion of the auricle of an Elephant. It is remarkable for the notches and perforations of its margin, all of which are natural. *Prepared by Mr. Clift.*

1619. The auricles of a Mandrill (*Papio Mormon*, GEOFF.). They present the elevations and depressions termed 'tragus' and 'antitragus', 'concha', 'sinus', 'fossa navicularis', 'ant-helix', but the reflection of the external margin of the auricle to form the 'helix' is present only at the upper part; and the pendent 'lobulus' is not developed from the lower part of the auricle.

1620. The auricle of a Gibbon (*Hylobates Lar*, ILLIG.). In this Ape the whole exterior margin of the auricle is bent forwards, forming the helix; which increases its capacity for catching sounds: the other parts of the auricle above mentioned are present, but the lobulus is wanting; and the texture of the auricle, as in the Mandrill, is thinner and less fleshy than in the Human Subject.

1620 A. The auricle of a young Orang Utan (*Simia Satyrus*, BLUM.). This differs from the preceding, and approaches the Human form in its increased thickness, and in the greater development of the tragus.

Prepared by Mr. Owen.

1620 B. The auricle of a young Chimpanzee (*Troglodytes niger*, GEOFF.). This differs from the preceding chiefly in its relative magnitude, being taken from an animal of the same size; in both the principal deviation from the human form may be observed in the less proportional extent of the auricle below the concha.

1621. The auricle of a Negro (Human Subject of the *Æthiopian Race*); it is characterized by its large size, and the want of a lobulus.

1622. The auricle of a New Zealander (*Malayan*, or *Neptunian Race*); it is relatively thinner and smaller than that of the Negro. The form of the lower part has been distorted by the weight of some heavy pendent ornament, for the support of which a large cicatrized perforation may be observed.

1622 A. The auricle of a Human Subject of the same race, from Tahiti. The lower part, which is closely attached to the integument, is similarly perforated. *Presented by Mr. Clift, F.R.S.*

1623. The auricle of a European Female (*Japetic*, or *Caucasian Race*). The lower part is thickened, and extended below the point of attachment of the auricle to the integument, forming the lobulus.

1624. The auricle, injected, of a European Male.

SERIES V. Organ of Sight.

"The Sense of Sight is perhaps the least common of any. It is that which gives the greatest scope of action, therefore is only for those animals which have progressive motion, and that not the least. I do not know of any animal possessed of this sense below the Insect.

"It is not so immediately connected with, or subservient to, the actions of life as either touch or taste; but is in this respect pretty much upon the same footing with hearing.

"The whole of this organ, in many animals, is very complex, being made up of many parts, and differing in some degree in different classes of animals.

"The construction of the organ upon which sight depends, as also the mode of impression, is perfectly understood; and one would at first imagine, as there is but one mode of impression, that the construction of this organ would be the same in all.

" The principle of sight itself is most probably the same in all; but the construction of all the parts is in many very different. The differences that immediately concern vision are but few, and perhaps are only in the different convexities of the crystalline humour, although the differences in the other parts may amount to a great many.

" All animals that see, as far as I am acquainted, have two organs of sight*. Their sight may be said to depend upon the three following effects of impressions, which are *form,* greater or less; *impression* in the same form or object, and *colour*; and as the first two of these depend upon the refraction of light, and as some of these refractive powers differ in some classes of animals with respect to number, I shall make our first division into those which have only one power of refracting in each organ, and those which have a great many. This difference appears to relate rather to the circumstance of motion in this organ than to any other in the principle of vision itself; so that this division might be into those which have, and those which have not, motion, and the construction necessary for these two conditions.

" Those [eyes] which have no motion have a multiplicity of refracting surfaces in the cornea, and which belongs, I believe, to all the aerial Insects.

" This class of animals have not only no motion in the eye, but they have hardly any in the head so as to assist or to act as a substitute. How far they have other refracting powers besides the cornea, I have not been able to ascertain.

" The intention of such a structure evidently appears as a substitute for motion; but the next question is, why not motion in the eyes of Insects as well as in other animals? One reason, I think, may be given: first, we may perceive that all Insects of flight have a considerable extent of progressive motion, therefore must have a large eye; and an eye of sufficient size could not be placed so as to have sufficient motion.

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* In many of the Entomostracous or lower organized Crustaceans the eyes are blended together so as apparently to constitute a single organ, and hence they are termed 'Monoculi.' Many Infusoria also present a single eye-speck.

"How far the focal distance in each refractor is the same, or how far they have a focus to each refractor, as if they were but one, I will not pretend to say; but I suppose there is but *one* focus to the whole.

"The first of this division, as far as I yet know, admits of but little variety; but the second of a great deal, which we shall now consider.

"The second of this division includes those eyes which have but one refractor, or perhaps more properly, series of refractors, and of course must have motion. To this division belongs, I believe, every other animal which has eyes except the above, even the aquatic Insects*. However, this motion in the eye is of various extent in different animals; some having a great deal, as the Chamelion, Hare, Deer; or very little, as the Cuttle-fish and Fish in general, Birds, &c.; but in many this motion is increased by the motion of the head, as in the Cuttle-fish, and in all Birds.

"I shall divide this organ into its different parts, beginning with their more immediate uses.

"The first part to be considered in this compound organ is the immediate organ of vision, or 'Retina.'

"The second is the refractive power, or that which gives figure or bounds, and disposes of the quantity of impression according to the object itself: they may be called the artists who give out and dispose of the colours, and are the 'Humours.'

"The third is the colouring matter of the bottom of the eye, or the back-ground of the surface of impression, which is all of one colour in the eyes of some animals, while it is of two different colours in others and of various colours in the same eye in many; it is called 'Pigment.'

"The fourth is the accommodation, or the forming of the whole, which takes in the different 'Coats.'

"The fifth, the motion of parts, and of the whole, taking in the "'Muscles.'

"The sixth, the different sizes of eyes in different animals.

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* By this term Mr. Hunter usually designates the class Crustacea; but although in a considerable division of this class the eyes are placed upon the extremities of moveable peduncles, yet they are provided with a compound cornea, which is divided, as in the flying Insects, into a number of distinct refractors or corneules.

"The first, or the organ of sense, is the retina. How far it belongs to every eye I am not certain. The Cuttle-fish appears not to have it*. It varies but very little in different animals. It is certainly a continuation either of, or from, the optic nerve; for it appears to spread out from the termination of that nerve. This is not so plain in many animals, especially the Quadruped, but in many it is very evident, as in Amphibia, and Fish. It is thin and semitransparent, at least as far as a whitish substance can be†.

"It lines more than one half of the posterior part of the cavity; that is, it comes further forwards than the middle of the eye. It is in most animals composed of a double substance, the one more pulpy than the other. It is not very vascular, although it has a good many vessels.

"For the management of the light there are the Humours, which are three, called 'aqueous,' 'crystalline,' and 'vitreous,' one of which is always retaining the shape peculiar to the original intent, viz. the crystalline; the other two will vary according to circumstances. The vitreous will vary in shape according to the shape of the sclerotic coat, the aqueous according to the shape of the cornea, &c.

"One great difference in the crystalline is the different convexities, which I shall first divide into two, which appear to be adapted to the different media through which the light passes; as, for instance, air and water.

"The different convexities in the crystalline humour admit of two modes of variety; the first, where it is convex on both sides equally, as in the Fish: the second, where one side is more convex than the other, as in the Human Subject.

"Both these forms admit of a greater or less degree of convexity. The degrees of convexity vary from the almost flattened lens of the Bird to the sphere, as in Fish in general.

"The background of the immediate organ of sight admits of great variety with respect to colour, and also with respect to kind. I shall divide it into the common and the particular, viz., that which is common to all, and that which is peculiar to some. This background is all of the same colour in many animals, while it is of two colours in others, and also of various colours in the same animal in some.

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* The retina exists in the eye of the Cuttle-fish, as is shown in Nos. 1630, 1631, &c., but situated differently with respect to the pigmentum nigrum to what it is in animals generally.

† From this it would appear that Mr. Hunter had not at this period examined the retina of an animal just killed, or he must have observed its entire transparency.—W. C.

"The common and the particular are always of different colours, for which the particular seems to be intended.

"That which is common to all, is in all of the same nature; but it varies in its shades of colour very considerably, even in the same species, in almost every animal; but much more in some species than in others.

"The Human, the Monkey, and most Birds are examples of this. In general it is black, or of a dark brown colour, from whence it has got in general the name of *nigrum pigmentum*; but we often find it of a light brown, while in others it is of a dirty white colour.

"In the Rabbit, we find it in some extremely black, while in others it is almost white. The same occurs in the Horse.

"In those animals where it is dark, it is pretty uniformly so through the whole; but in those where it is lighter it is not so uniform. The lightest part is always at the bottom of the eye, becoming gradually darker forwards, and in such it is often quite black; viz. from the termination of the retina to the pupil; or if not black, it is there much darker than anywhere else.

"This is generally the case in the eyes of the Human Subject, and in Horses which have light eyes; but not in the Rabbit or Ferret. In the Rabbit it is pretty much of the same colour throughout the whole eye; if it is dark, it is universally so, if light, the same.

"In those species of animals where it is composed of the common and the particular pigments, it is pretty uniformly the same through the same species, yet it is sometimes varying; and where it does it is in the common pigment, not in the particular; and this variety of colour is always from the dark towards the light, as in the Horse: and even in the Horse, where this is the case, the common pigment is always becoming darker forwards, as mentioned in the Human, and the same animal, where it is varied.

"The peculiar pigment is of a different texture, and is superadded to the common. It is of a different colour in different *genera* of animals; but of whatever colour it is in any *genus*, it is uniformly so through the whole. In some it is only of one colour. The Lion and perhaps most carnivorous quadrupeds are of this class. But in other animals it is of various colours in the same genus; but here too it is uniform. The Cow, and perhaps most herbivorous quadrupeds, are of this class.

"The background covers the retina everywhere; also between the termination or edge of the retina and the edge of the crystalline where this body is attached to, or covers, the vitreous humour; at the same place lining the processes, to be described; and then it goes to line the iris.

"Besides this, in many animals we find it on the outside of the next coat, or choroid, as it were, mixed or like dark dust in the cellular membrane which attaches that coat to the external coat.

"The next coat to this pigment is called the choroid. It covers the preceding coat everywhere, or may be said to cover the vitreous humour everywhere; and also the fore part of the crystalline, excepting opposite to the centre of that humour, where it is perforated, which perforation is called the pupil; and it is perforated also at the termination of the optic nerve.

"The anterior perforation is to be considered as a window for admitting the light. It is of various shapes in different animals; in some it is round, as in the Human Subject, Monkey, all Birds, and many Fishes. In some it is two segments of large circles joined, which gives it a long and a short axis, as in the Lion, Cat, &c.: in others it is oblong, as in Horses, Cows, Sheep, &c. The long axis in some is vertical, as in the Cat; in others, horizontal, as in the Horse, &c. In some animals, again, it is an oblong bent figure, or concave, on one side, while it is convex on the other, somewhat of the shape of a crescent, as in the Skate, Cuttle-fish, &c.

"Where the choroid coat covers the retina, or rather where it covers the pigmentum of that organ, it is smooth; but where it covers that part of the vitreous humour which is between the anterior edge of the retina and the outer edge of the crystalline, it is there thrown into folds, whose direction is in the long axis of the eye. They begin posteriorly; they arise, as it were, insensibly, becoming broader and broader, or rather deeper and deeper, forwards, where they terminate all at once. From thence the choroid is continued forwards, before the crystalline some way, being perfectly detached on both sides, where it loses the name of choroid and takes that of iris.

"In the Bird the choroid coat appears to send in a pretty broad process in the centre of the optic nerve, which process is sunk in the vitreous humour. It is thin, of a quadrangular figure, or rather a parallelogram, attached by one long edge to the coats, by the other to the vitreous.

"There is something similar to this in Fishes.

"The choroid coat is thin, and extremely vascular, receiving its arteries through the outer coat, and returning the veins through the same. The arteries have nothing very particular, but the veins all pass forwards, converging [at different parts] to one point or vessel, which is reflected back before it passes through the outer coat. From this circumstance, of its being extremely vascular, and no visible purpose answered by it, one would imagine that it had, behind the processes, some immediate connexion with vision; but as it is equally vascular through its whole extent, where it cannot be considered as an immediate organ of sense, we can hardly allow it to be such in any degree.

"The nerves of vision are called the optic. They are the second pair from the brain in most animals of the last division [or Mammalia], although not in all; for they are the first in the Porpesse, that animal not having the olfactory. They are very large when compared to the nerves of touch of the same extent of surface; even larger than those of taste or smell, but perhaps pretty much upon a par with those of hearing. How far this nerve exists in the aerial Insects*, I am not acquainted, but it is very plain in the Lobster.

"The external coat is that which incloses the whole apparatus. It is, as it were, the external frame of the organ of vision. It also gives shape, &c., to the whole eye. It is, in general, a circumscribed covering, having no openings into it; but it is not so in all eyes, for in the Cuttle-fish it is perforated forwards in the same manner, and of the same shape as the choroid in that fish.

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* The visual nerves in this class are given off from an optic ganglion analogous to that of the Cuttle-fish.

"It is called the sclerotic or tunica albuginea.

"The exterior portion of this, or that part which makes the external part of the body, is transparent, called the cornea, similar to a glazed window.

"The sclerotic coat is of various shapes in the various classes of animals. It is nearly a large section of a sphere in the most perfect, having the cornea projecting a little from its being a section of a smaller sphere.

"In the Bird, this inequality is much greater: the sclerotic coat forms a neck at the opening, upon which is placed the cornea. This is much more so in some Birds than in others, as in the Eagle. Although this neck is not so remarkable in the eyes of other animals, yet there is a neck upon the humours of these, made by the projection of the ciliary processes inwards, and more in some than in other animals.

"The sclerotic coat is formed of various substances in different animals. In the most perfect animals it is of a tendinous nature.

"In the Bird, it is composed partly of the same substance, and partly of bone.

"In Fish, it is principally cartilage; but in some it is bone, as in the Sword-fish.

"In Insects it is principally horn.

"It is of various thickness in different animals, and is also thicker in some parts than others in the same animal, especially in the Whale, Porpesse, &c. It is of various colours in different animals, but in most it is white, as in the Human Subject; but in some others it is of different colours, as in the Lion.

"Although the sclerotic coat gives the external figure to the eye, yet it does not in all give the shape of the cavity which immediately surrounds the vitreous humour. In the Quadruped the *processus ciliares* alter that form; in Birds the same processes and the marsupium alter that form; and in many Fishes there is fat in some, and some other substances in others, which in many are of considerable thickness, especially at the bottom of the eye.

"The cornea is the transparent part of the globe of the eye. It is that which is exposed, or may be said in some measure to make a part of the external surface of the body, especially in those which have no eyelids, as Snakes, Lobsters, and Insects.

"In Quadrupeds, Birds, Fishes, there is no saying what substance it is composed of, as it is not like anything else in the animal body.

"In the Snake, Lizard, and in Insects in general, it is horn, and is a continuation of the cuticle or external covering; and when the animal casts its coat, it is also cast along with it*.

"In the Flying Insects it is divided into many sections, and makes the largest part of the eye.

"It is relatively of different sizes in different eyes: in the Whale it is very small, while in the La Paca (*Cavia Paca,* Linn.) it is extremely large. This circumstance gives a superiority as to extent of vision in the latter animal over the other, in proportion to their size.

"The organ of sight varies more in relative size than any of the other organs of sense. Touch, we observed, must be in some degree in proportion to the size of the animal. The organ of taste very nearly the same†. Smell not quite so much; however, in a great degree. Hearing less so, especially when we take in all its accessory parts.

"It hardly appears as if intended that the eye should bear any proportion in size with the body, but in proportion to the progressive motion of the animal so far as this depends upon immediate sight. As no eye would be sufficient to take in the whole, a succession of extents was necessary to complete the whole, and consequently motion. However, as the progressive motion, in a great many animals, will bear some proportion to the size of the body, so far does the organ of sight correspond.

"An Elephant has a smaller eye than a Horse; a Squirrel and a Rat have much larger eyes than a Mole; although the progressive motion of a

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* In these Reptiles the true cornea is covered by a firm transparent non-adherent conjunctiva, which is shed at the time of shedding the skin, but not the cornea.

"† The Elephant might be supposed to be an objection to this, but I suspect the trunk is an assistant."

Mole may be nearly as great as either; but it has no occasion for immediate extent of sight; it wants to see objects near, but must have a succession of them, because his food has but little motion, therefore it seldom comes to him; and for these his progressive motion is adapted.

"An Eagle has nearly as large an eye as an Elephant, perhaps the largest eye of any bird in proportion to size. An Eagle does not want a succession of sight, for his food is not stationary; he therefore wants at once to take in a large sphere of vision, that he may have a better chance to discover his prey; for this is such as has, in general, a good deal of progressive motion, therefore if he were shorter-sighted he might as well be stationary, and the food would in its course come within his sphere of vision: but by a large eye he has two advantages, viz. that of its coming in his way, and his seeing it at a considerable distance.

"The eyes of animals which see in the dark, and are also to see objects at some distance, are large, as much on account of the darkness as the distance of the object.

"The eye of an animal which can see an object at a mile's distance in the middle of the day, ought to be much larger to see the same object at the twentieth part of that distance at night: but as a substitute for the want of size, the motion of the iris and the white pigment or background assists.

"A motion in the eye only belongs to those which have but one series of refractors, which are the second of our first division.

"The movers or the muscles of the eyes of animals are, in most, pretty simple; an eye can have but three kinds of motion, two of which are to keep the object fixed in its place on the retina; the other to retract the whole eye deeper into its socket.

"The first kind of motion I shall call that which directs the refractor towards the object, either when the object moves out of the line of direction, or when the body in which the eye is placed moves out of the line of direction. This kind comprehends every motion of a body from a centre to a circumference, and also the whole circumference itself, the ball of the eye appearing to move on the optic nerve, in many, as a centre of motion. These motions are performed by four straight muscles.

" The second is that motion of the eye which preserves the object from rotating upon the retina, either when the object turns upon a centre, or when the head moves laterally, which is upon a centre somewhere.

" Although this last motion is not upon the centre of the eye, yet it obliges the eye to move in a circle ; which obliges the eye to move so far upon its axis as it moves in this circle. For either moving the eye upon its axis when an object is moving upon its axis, or for staying the eye when the head is moving upon some axis, are the oblique muscles placed.

" Besides the four straight and two oblique, in many animals there are muscles inclosing the optic nerve, which would appear to be a retractor ; for we find in some animals that they have a power of drawing the eye almost into the head, as in the Horse, Deer, &c."

Hunterian Manuscript Catalogue.

A. *EYES IMMOVEABLE AND NUMEROUS, OR WITH MANY SERIES OF REFRACTORS.*

Subseries 1. *In Arachnidans.*

1625. A portion of the anterior segment, or cephalothorax, of a Scorpion (*Scorpio Africanus*, LINN.), showing the disposition of the eyes. These are eight in number, two of which are of large size, and are situated on either side of an elevation in the middle of the dorsal surface of this segment ; one of them has been bisected in the preparation, and the large crystalline lens is shown : the remaining six are disposed at the anterior angles of the cephalothorax, three on each side ; those of the right side only are here preserved.

1625 A. A Bird-spider (*Mygale avicularia*, LATR.), in which the eyes, eight in number, are all disposed in a transverse cluster, on an elevation near the anterior margin of the first segment of the body, or cephalothorax.

Prepared by Mr. Owen.

2. *In Insects.*

1626. The head and thorax of a large Dragon-fly (*Æsthna grandis*, FABR.), with the eyes dissected. On the right side the superior moiety of the anterior part of the eye has been removed, exposing the cavity of the eye, and demonstrating the thickness of the tessellated cornea; on the left side some of the anterior layers of the cornea have been removed.

1627. Portions of cornea removed from the eye of a Dragon-fly.

B. *EYES MOVEABLE, AND A SINGLE PAIR, WITH A SINGLE SERIES OF REFRACTORS.*

A. *STRUCTURE OF THE EYEBALL.*

a. Adapted for seeing in Water.

3. *In Gastropods.*

1628. The eye of a Murex bisected, showing the large spherical lens, choroid pigment, and sclerotic.

4. *In Cephalopods.*

1629. A portion of the head, with the eyes, of a Cuttle-fish (*Sepia officinalis*, Linn.). In this preparation are shown the brain in its cartilaginous skull, the optic nerves and ganglions; and on the right side a section of the eyeball has been made to show its structure.

The principal peculiarities in the eye of the Cephalopod are the following: the cornea is composed exclusively of a continuation of the common integuments, and does not adhere to the margins of the anterior aperture of the sclerotica. The membrane lining the chamber of the aqueous humour anterior to the lens is consequently reflected over the exterior of the sclerotica, and upon a ligamentous aponeurosis continued from the margin of the cartilaginous orbit, before it reaches the back part of the cornea; a much larger cavity therefore intervenes between the cornea and lens than in the higher animals, in which the sclerotic aperture is closed by the cornea. A second large cavity, exterior to the eyeball, intervenes between the sclerotica and the cartilaginous orbit, in which is situated the large reniform optic ganglion, and a quantity of white and apparently glandular substance. The fibres of the optic ganglion expand into the retina immediately anterior to the sclerotica, and terminate anteriorly in a ciliary zone, which is implanted in a circular groove in the substance of the lens. For an explanation of the different parts of this preparation see the description of its figure as it appeared when recently dissected. (Plate XLII. fig. 2.)

1630. A section of the eye of the Cuttle-fish, with the optic or reniform ganglion; showing the fibrous texture of that ganglion, the extended surface at which those fibres penetrate the sclerotica, and the layer of nervous matter, or retina, in which they terminate. This layer is applied immediately to the cartilaginous sclerotica; it becomes thinner as it advances forwards, where a number of small regular plicæ are formed upon its inner surface. The ante-retinal pigment has been removed.

1631. The eye and reniform optic ganglion of the Cuttle-fish. The fibres of the ganglion have been unravelled, and the mode in which they penetrate the sclerotic by fasciculi is distinctly displayed. Part of the sclerotic has been removed to show the thick layer formed by the nervous filaments, and a smaller portion of this layer has been reflected upwards to show the pigmentum nigrum, covering the whole of its anterior or central surface, and consequently interposed between the impinging rays of light and the sentient membrane. The pigment does not, however, adhere to the retina, which is perfectly smooth on the side next the pigment, while it is rough and cellular on the opposite side next the cartilaginous sclerotica. The posterior surface of the pigment is covered by a very thin layer of white substance, which apparently is not derived from the retinal expansion. This tunic, which from its relative position would seem to represent both choroid and retina blended together, becomes thinner as it advances forward, and near the lens is disposed in a zone of small plicæ, which are fixed in a circular groove of the crystalline. The fibrous and cartilaginous laminæ of the sclerotica, and the anterior crescentic aperture of that tunic are also shown.

1632. A section of the eye of the Cuttle-fish, showing the space behind the proper globe of the eye, comprehended between the cartilaginous orbit and sclerotica, and containing the optic ganglion and the peculiar lobules of a soft white substance above mentioned, which serve, apparently, to obviate the effects of pressure on the ganglion. The cartilaginous layer of the sclerotica is well displayed, also the retinal expansion anterior to it, a part of the ante-retinal pigment, and the crystalline lens, which is transversely divided at the groove in which the ciliary zone is implanted.

1633. The anterior part of the eye of a Cuttle-fish, exhibiting the crystalline lens *in situ.*

1633 A. The crystalline lens and capsule of the Cuttle-fish, showing its mode of attachment to the ciliary zone, which is inserted into a circular groove; about one third of the lens being anterior to the zone, the remainder projecting into the vitreous humour.

Presented by Sir Anthony Carlisle, F.R.S.

1634. The anterior and posterior divisions of the crystalline lens, with a section removed from the former. A greater part of the lens still preserves its transparency and peculiar deep-brown colour.

1635. A section of the crystalline lens, showing the hard central nucleus, unaltered by the spirit and transparent.

1636. A similar preparation of the lens, in which a greater proportion of the central part retains its transparency. This preparation is figured in the *Philosophical Transactions* (vol. lxxxiv. tab. v. fig. 1.), but the elliptical form there given is owing to the preparation having been drawn while in the bottle of spirit.

1637. The crystalline lens prepared to show its laminated composition.

1638. A similar preparation, showing the fibrous structure of the laminæ.

1639. A similar preparation.

1640. A similar preparation, with the central nucleus removed.

1641. A section of the lens, with the laminæ successively raised as far as the nucleus, whose compactness of structure renders it difficult to demonstrate their existence. This preparation is figured in the *Philosophical Transactions* (vol. lxxxiv. tab. v. fig. 2.), but the elliptical shape there given to the lens arises from the same cause as is mentioned in the description of No. 1636.

1642. A section of the orbit and contiguous parts of the head, with the eye, of a Cuttle-fish. The orbit and tunics of the eye are exposed by a posterior section, which shows the extent of the cartilaginous cup forming the posterior part of the orbit, and at the same time the corresponding parietes of the cavity containing the optic ganglion and surrounding glandular substance: the ganglion has been removed, but part of the glandular substance remains. The external or fibrous layer of the sclerotic is next exposed, and beneath it the glistening cartilaginous layer, a smaller portion of which is cut away to show the fibrous retinal expansion of the optic ganglion. The anterior cavity between the eye and the integument is laid open, showing the transparent cornea, formed exclusively by the integument and loosely applied over, without adhering to, the anterior aperture of the sclerotica, through which the lens partially protrudes. This cavity is lined by a thin membrane, which is reflected upon the posterior part of the sclerotica.

1643. A transverse section of the eye, showing the structure of the sclerotic, its thinness, and glistening exterior surface.

1644. The sclerotic coat of the eye, exhibiting the form of the anterior aperture.

1645. The eye of a Cuttle-fish *in situ*, with the soft parts surrounding the orbit. The cornea and contiguous integument have been removed, exposing the large chamber anterior to the crystalline lens and sclerotica, both of which are immediately brought into view. The aperture of the sclerotica through which the crystalline partially protrudes, and the curtain-like process of the sclerotic which encroaches upon the aperture, are well displayed.

1646. A portion of the integument, with the transparent cornea which passes over the front of the eye, of the Cuttle-fish.

5. *In Fishes.*

1647. The optic nerve, with part of the choroid and retina of the Sword-fish (*Xiphias Gladius*, Linn.). The nerve is prepared to demonstrate its peculiar structure, being composed of a flattened layer of nervous matter longitudinally folded: where it penetrates the choroid and membrana Ruischiana it becomes much contracted in diameter. The retina, as it expands upon the choroid, preserves, but in a less degree, the same folded character as the nerve.

1648. The posterior part of the eye of the Moon-fish (*Orthagoriscus Mola*, Schneider), showing the diminished size of the optic nerve at its termination on the membrana Ruischiana, and the beautifully minute radiate disposition of the commencement of the retina; by which structure that membrane may be seen to be continued upon the peculiar vascular production or falciform ligament (analogous to the marsupium in Birds), which passes from the choroid coat to the crystalline lens through the substance of the vitreous humour.

In this preparation may also be noticed the abundant loose cellular substance between the choroid and sclerotic coats.

1649. Another section of the same eye, showing the anterior margin or boundary of the retina at the distance of nearly an inch from the margin of the pupil; also the falciform ligament attached to a portion of the ciliary zone, to which it is continued, following the concavity of the eye, from the insertion of the optic nerve.

1650. A portion of the choroid and retina, with the falciform ligament, part of the vitreous humour, and crystalline lens of the eye of the Moon-fish. The whole line of adhesion of the falciform ligament to the under surface of the eye, and the continuation of the retina upon it, are distinctly shown. In this preparation may also be noticed the spherical form, characteristic of the lens in Fishes, which compensates for the flatness of the cornea and the absence of the aqueous humour.

1651. A longitudinal section of the eye of the Bonito (*Thynnus Pelamys*, Cuv.), principally to show the falciform ligament, along which the colouring-matter of the choroid is continued. The disposition and extent of the retina, the choroid gland, the flattened cornea, and other peculiarities of the eye in Fishes may also be noticed in this preparation.

1652. The vitreous and crystalline humours of the eye of the Cod-fish (*Gadus Morrhua*, Linn.).

1653. The spherical lens and part of the vitreous humour of some large Fish.

1654. The spherical lens of a large Fish.

1655. The capsule of the crystalline lens of the Moon-fish.

1656. Parts of the sclerotic coat, membrana argentea, and choroid gland of the Moon-fish, to show the structure of the latter substance, which is peculiar to osseous fishes. It is always situated between the silvery membrane and the true choroid, and is extended more or less, and in different forms, about the termination of the optic nerve, which is here preserved. In the present species it almost completely encircles the nerve in the form of an oval ridge, and its structure appears fibrous, whence it has been considered muscular; but the fibres consist in reality of minute, parallel, and closely disposed vessels, which in the recent state are of a bright red colour. The use of this part has not been determined.

1657. The remaining portion of the choroid gland of the same eye, with parts of the retina, choroid coat, and membrana argentea: the latter membrane is dissected off so far as to show the posterior surface of the choroid gland; it exhibits the apparently fibrous texture as in the preceding preparation, and the tortuous vessels may be observed which go from the gland to form the 'membrana Halleri' in the choroid.

1658. The posterior segment of the eye of a large bony Fish, showing part of the falciform ligament and the choroid gland.

1659. The posterior part of the eye of a Salmon (*Salmo Fario,* Linn.), showing the hard sclerotic coat, and the choroid gland.

1660. A longitudinal section of the eye of the Wolf-fish (*Anarrhichas Lupus,* Linn.), showing the different coats of the eye, and the choroid gland, *in situ.*

1661. A longitudinal section of the eye of a Sword-fish (*Xiphias Gladius,* Linn.), showing the choroid gland and the tortuous vessels passing from it to the choroid, together with part of the falciform ligament.

In this preparation there may also be observed the plicated structure of the optic nerve as displayed in a transverse section; the ciliary plicæ of the uvea; the absence of true ciliary processes; and portions of the two hemispherical osseous plates of the sclerotic, which completely encircle the globe of the eye: these plates terminate anteriorly in a rounded and dilated border, to which the ciliary ligament is applied: the cornea appears to be continued partly from the integument, and partly from the external membrane of the sclerotic.

1662. The corresponding section of the preceding preparation, with the cornea removed to show more distinctly the iris (which in osseous fishes is endowed with little or no mobility), and the application of the ciliary ligament to the dilated margin of the bony plates of the sclerotica.

1663. The osseous sclerotic plates of the eye of the Bonito, which in number, form, and situation are the same as in the Sword-fish.

1664. The osseous plates of the sclerotica, together with the flattened cornea, of the Albicore (*Scomber Thynnus*, Linn.).

1665. A section of the anterior part of the sclerotica and cornea of the Moon-fish, showing their mode of connexion, and the laminated structure of the latter part. The anterior margin of the sclerotica is thickened and rounded: the posterior layer of the cornea is continuous with the external membrane of the sclerotica, the anterior layers are productions of the integument.

1665 a. The cartilaginous sclerotic coat and cornea of the Moon-fish.

Presented by Mr. English, 1823.

1666. A longitudinal section of the eye of a Sturgeon (*Acipenser Sturio*, Linn.), showing the thick cartilaginous cup imbedded in the fibrous layer of the sclerotica, the dense membrane investing the optic nerve which may be traced to its termination in the eye, and a small part of the retina. The humours have been removed from this preparation, so that the choroid and iris, the cornea, and the relative sizes of the cavity of the eye to the entire globe, are clearly displayed.

1667. The posterior moiety of the eye of the Grey Shark (*Galeus communis*, Cuv.), from which the vitreous humour has been removed in order to show the retina. This membrane consists of two layers easily separable; a portion of the central and most fibrous layer has been removed.

1668. The crystalline lens and part of the vitreous humour of the Grey Shark.

1669. Sections of the two eyes of the Grey Shark, the upper one showing the "membrana argentea,' the lower one the dark choroid behind it.

1670. The eye of the Grey Shark, transversely divided. The posterior section is suspended by the slender cartilaginous eye pedicle, and shows the termination of the optic nerve and part of the choroid coat. The anterior section exhibits the ciliary plicæ and the peculiar quadrangular form of the pupillary aperture; also the flattened cornea, and the corresponding limited extent of the anterior chamber.

1670 A. The anterior portion of the eye of the Basking Shark (*Selache maxima*, Cuv.), showing the ciliary plicæ, iris, and pupil; the latter is of an elliptical form: the ciliary plicæ consist each of two or three minute folds, which, as they run forward, unite into one, and terminate in a point at the circumference of the iris, but do not project freely inwards as distinct processes from the surface of the choroid membrane. In this preparation may also be observed the flattened cornea and its connexions with the external integument and the cartilaginous sclerotica.

Prepared by Mr. Clift.

1670 B. The posterior section of the same eye, showing the insertion of the optic nerve, the dark choroid, with some of the ciliary nerves, and the cartilaginous sclerotic coat. *Prepared by Mr. Clift.*

1670 C. A longitudinal section of the eye of a Basking Shark. It shows the relative thickness of the cartilaginous sclerotic at different parts, being thinnest, as is usual in the higher classes of animals, at a short distance from the anterior margin, where it is again thickened. The cornea is evidently seen to be principally a continuation of the integuments over the anterior aperture of the sclerotic, the margin of which is thickened and rounded, but not grooved for the reception of the cornea. The attachments of the cartilaginous pedicle to the back part of the sclerotic, and those of the muscles of the globe, with the exception of the 'rectus abductor,' are also shown in this preparation. The spherical lens lies at the bottom of the bottle. *Prepared by Mr. Clift.*

1671. A longitudinal section of the eye of a large Skate, showing the layers of the choroid and the fringed and curtain-like process depending from the superior margin of the iris.

1672. A similar section of the opposite eye of the same Skate, showing the cartilaginous and fibrous layers of the sclerotica. In both preparations the flattened cartilaginous peduncle of the eye is preserved; it is articulated by a synovial arthrodia with a cartilaginous protuberance at the back part of the sclerotica; the capsule of the joint is preserved entire in the present preparation, but is laid open in the preceding one.

1673. A section of the eye with the eye-stalk of the Devil-fish (*Cephaloptera Giorna,* Cuv.). The cartilaginous layer of the sclerotica is of great thickness posteriorly, where it sends off processes both for the insertion of the eye-muscles and for the articulation of the expanded extremity of the pedicle; the capsule of this joint is laid open. The vitreous humour is removed from the cavity of the eye, but the lens is preserved *in situ*; as are also the retinal and choroid coats; the termination of the former at the commencement of the ciliary zone is clearly demonstrated.

6. *In Reptiles.*

1674. The eye of a Turtle (*Chelonia Mydas,* Brongn.), transversely divided. The short ciliary arteries are injected, and form a beautiful plexus around the optic nerve. The nerve makes a conical projection at its entrance into the cavity of the eye. The choroid is thick and of a brown colour, the posterior part of the iris and ciliary circle, from which the area appears to have been removed, are of a lighter colour. The ciliary plicæ are neatly defined, but, as in Fishes, do not project forward as distinct processes. The iris and pupil are round. The sclerotica is cartilaginous, and is of unequal thickness, this being greatest at the posterior part, where it is also thicker at the temporal than at the nasal side of the globe; anteriorly it contains a circle of small bony plates. The cornea is circular and flat.

1675. A similar preparation, showing also some of the ciliary arteries and nerves.

1676. A portion of the eye of a Turtle injected, showing the continuation of the optic nerve into the retina.

1676 A. The vitreous and crystalline humours of the eye of a Turtle; the lens is almost spherical, but slightly flattened anteriorly.

Presented by Mr. Owen.

7. *In Mammals.*

Most of the preparations in this Subseries are derived from the Cetaceous Order, in which the organ of vision is described by the Founder as follows.

"The eye in this tribe of animals is constructed upon nearly the same principle as that of quadrupeds, differing, however, in some circumstances; by which it is probably better adapted to see in the medium through which the light is to pass. It is, upon the whole, small for the size of the animal, which would lead to the supposition that their locomotion is not great; for, I believe, animals that swim are in this respect similar to those that fly: and as this tribe come to the surface of the medium in which they live, they may be considered in the same view with birds which soar; and we find birds that fly to great heights and move through a considerable space in search of food, have their eyes larger in proportion to their size.

"The eyelids have but little motion, and do not consist of loose cellular membrane, as in quadrupeds, but rather of the common adipose membrane of the body; the connexion, however, of their circumference with the common integuments is loose, the cellular membrane being less loaded with oil, which allows of a slight fold being made upon the surrounding parts in opening the eyelids. This is not to an equal degree in them all, being less so in the Porpesse than in the Piked Whale.

"The tunica conjunctiva, where it is reflected from the eyelid to the eyeball, is perforated all round by small orifices of the ducts of a circle of glandular bodies lying behind it.

"The lachrymal gland is small, its use being supplied by those above mentioned; and the secretion from them all I believe to be a mucus similar to what is found in the Turtle and Crocodile. There are neither puncta nor lachrymal duct, so that the secretion, whatever it be, is washed off into the water.

"The muscles which open the eyelids are very strong: they take their origin from the head, round the optic nerve, which in some requires their being very long, and are so broad as almost to make one circular muscle round the whole of the interior straight muscles of the eye itself. They may be divided into four, a superior, an inferior, and one at each angle: as they pass outwards to the eyelids, they diverge and become broader, and are inserted into the inside of the eyelids almost equally all round. They may be termed the dilatores of the eyelids; and, before they reach their insertion, give off the external straight muscles, which are small, and inserted into the sclerotic coat before the transverse axis of the eye: these may be named the elevator, depressor, adductor, and abductor, and may be dissected away from the others as distinct muscles. Besides these four going from the muscles of the eyelid to the eye itself, there are two which are larger, and inclose the optic nerve with the plexus. As these pass outwards they become broad, may in some be divided into four, and are inserted into the sclerotic coat, almost all round the eye, rather behind its transverse axis.

"The two oblique muscles are very long; they pass through the muscles of the eyelids, are continued on to the globe of the eye between the two sets of straight muscles, and at their insertions are very broad; a circumstance which gives great variation to the motion of the eye.

"The sclerotic coat gives shape to the eye, both externally and internally, as in other animals; but the external shape and that of the internal cavity are very dissimilar, arising from the great difference in the thickness of this coat in different parts. The external figure is round, except that it is a little flattened forwards; but that of the cavity is far otherwise, being made up of sections of various circles, being a little lengthened from the inner side to the outer, a transverse section making a short ellipsis.

"In the Piked Whale the long axis is two inches and three quarters, the short axis two inches and one eighth.

"The posterior part of the cavity is a tolerably regular curve, answering to the difference in the two axises; but forwards, near the cornea, the sclerotic coat turns quickly in to meet the cornea, which makes this part of the cavity extremely flat, and renders the distance between the anterior part of the sclerotic coat and the bottom of the eye not above an inch and a quarter.

"In the Piked Whale the sclerotic coat at its posterior part is very thick; near the extreme of the short axis it was half an inch, and at the long axis one eighth of an inch, thick. In the Bottle-nose Whale, the extreme of the short axis was half an inch thick, and the extremes of the long axis about a quarter of an inch, or half the other.

"The sclerotic coat becomes thinner as it approaches to its union with the cornea, where it is thin and soft. It is extremely firm in its texture where thick, and from a transverse section would seem to be composed of tendinous fibres, intermixed with something like cartilage; in this section four passages for vessels remain open. This firmness of texture precludes all effect of the straight muscles on the globe of the eye, by altering its shape, and adapting its focus to different distances of objects, as has been supposed to be the case in the human eye.

"The cornea makes rather a longer ellipsis than the ball of the eye, the sides of which are not equally curved, the upper being most considerably so. It is a segment of a circle somewhat smaller than that of the eyeball, is soft, and very flaccid.

"The tunica choroides resembles that of the Quadruped; and its inner surface is of a silver hue, without any nigrum pigmentum.

"The nigrum pigmentum only covers the ciliary processes, and lines the inside of the iris.

"The retina appears to be nearly similar to that of the Quadruped.

"The arteries going to the coats of the eye form a plexus passing round the optic nerve, resembling in its appearance that of the spermatic artery in the Bull and some other animals.

"The crystalline humour resembles that of the Quadruped, but whether it is very convex or flattened I cannot determine, those I have examined having been kept too long to preserve their exact shape and size. The vitreous humour adhered to the retina at the entrance of the optic nerve.

" The optic nerve is very long in some species, owing to the vast width of the head.

" I shall not at present consider the eye in animals of this tribe as it respects the power of vision, that being performed on a general principle common to every animal inhabiting the water, more especially as I am only master of the construction and formation of the eye, and not of the size, shape, and densities of the humours; yet, from reasoning, we must suppose them to correspond with the shape of the eye, and the medium through which the light is to pass."

Hunter, On Whales, Phil. Trans. 1787, p. 437.

1677. The eye of a Porpesse (*Phocæna communis,* Cuv.) longitudinally divided, showing the thick retinal expansion of the optic nerve; the thin white choroid; the ciliary zone and iris, to which parts the brown pigment is confined; the flaccid cornea; and the sclerotic coat, which is of great thickness at the back part of the eye.

1678. The eye of a Porpesse, from which the cornea and humours have been removed, showing the collapsed retina and the thin and light-coloured choroid.

1678 a. The eye of a Whale (*Balæna Mysticetus,* Linn.) divided transversely into two equal hemispheres. By this section, in consequence of the great thickness of the sclerotic posteriorly, the cavity of the globe is left almost entire in the anterior hemisphere, being laid open just beyond the entrance of the optic nerve. On the outside of the posterior hemisphere may be observed the optic nerve surrounded and protected as it passes into the sclerotic by an elastic bed formed of a vascular plexus, the interstices of which are filled with oil: on the inside or cut surface may be observed the termination of the same nerve and commencement of the retina, which is plicated in a radiated manner. The choroid, as in the rest of the Cetacea, is of a bluish white colour; but the cellular membrane which connects it to the sclerotic is of a light brown hue. At a little distance from the choroid are several orifices for the short ciliary vessels; at the circumference of the sclerotic are four nearly equidistant apertures, which are sections of the ligamentous canals for the passage of the long ciliary arteries and the vorticose veins. The texture of the sclerotic is the same as in other Mammalia, viz. fibrous and reticulate; consequently much less dense than in Fish, where it is strengthened by cartilaginous or bony substance; but this difference in texture is compensated for by the great thickness of the sclerotic, which renders it equally fit for preserving the irregular form of the cavity of the eye arising from the flatness of the cornea, and for defending the delicate parts within from the effects of pressure from without. *Prepared by Mr. Clift.*

1679. A transverse section, including the posterior half, of the cavity of the eye of the Piked Whale (*Balæna Boops*, Linn.), showing externally the vascular plexus surrounding the optic nerve, and internally the retina collapsed, part of the vitreous humour coagulated and contracted, the bluish white choroid, and the cellular structure connecting it to the sclerotica, the orifices of the cut vessels of the tunica Ruyschiana, the thickness of the sclerotic at this part of the eyeball as compared with the succeeding section, and the four marginal canals for the long ciliary arteries and vorticose veins.

1680. The anterior section of the same eye, from which the cornea, the vitreous humour, and the retina have been removed, to show the iris and ciliary processes. It may be observed that these parts are covered with a dark pigment which extends a short distance upon the choroid, so as to prevent the rays of light being a second time reflected, and falling to disturb the spectrum on the back part of the retina. The form of the ciliary processes is beautifully shown in this preparation: of the numerous minute folds which constitute the ciliary zone, every third, fourth, or fifth becomes enlarged, is produced forwards, and forms a wrinkled corrugated process, about three lines in length, compressed laterally, and terminating rather obtusely; the intermediate processes are shorter, but vary in length: the larger processes are about seventy in number. The peripheral radiated, and the central circular fibrous portions of the iris are distinctly visible on this surface: on the opposite side may be seen the wavy vessels of the iris radiating from the arterial canals which surround the margin of the pupil. This aperture is transversely oblong; the anterior aperture of the sclerotic is elliptical, with the sides unequally curved.

1681. Part of the cornea removed from the preceding preparation. The cut surface shows it to be much thinner at the centre than at the circumference. Mr. Hunter states that it is soft and very flaccid.

1682. The other half of the cornea of the same Whale, in which its laminated structure is demonstrated.

1683. The anterior part of the choroid, with the iris and ciliary processes, of the Piked Whale. Bristles are placed in the long ciliary arteries which, advancing in the direction of the long axis of the pupil, may be seen to terminate in a canal surrounding at a little distance the pupillary margin. Wavy branches radiate from this canal to the circumference of the iris. The veins of the choroid surrounding the iris have been injected.

1684. The vitreous and crystalline humours of the eye of the Piked Whale. The lens had lost part of its shape from the putrescent state of the eye at the time it was examined; but it appears to have been of a spherical form.

1685. A section of the crystalline lens of a Whale, showing its subspherical form, and dark-coloured eccentric nucleus.

1686. A similar preparation.

1687. A similar preparation.

In all these sections the nucleus is seen to be situated in the posterior half of the lens, and the surrounding laminæ are reflected inwards and backwards towards the middle of the anterior surface of the nucleus, leaving a funnel-shaped cavity in front of it, which appears to be filled up by a softer substance.

1688. The eye of a Porpesse, injected, and the cornea removed to show the iris and the form of the pupil. The anterior surface of the iris is characterized by the wavy vessels which converge towards the pupil. This aperture is oblong, and is slightly encroached upon by a process descending from the superior margin of the iris.

1689. The eye of the Bottle-nose Whale (*Hyperoodon Dalei,* Cuv.), from which the cornea has been removed to show the iris, the structure of which is precisely similar to that of the iris of the preceding species. A small portion of the sclerotica is cut away, showing its prodigious thickness, and exposing part of the choroid.

1690. A portion of the eye of the same species, in which the canal of one of the long ciliary arteries is laid open, and the continuation of the vessel to the pupillary margin is shown. The canal of a vein receiving the blood at the circumference of the iris is also laid open, and a bristle inserted in the trunk of another similar vein. The structure of the sclerotic and choroid coats is well displayed in this section.

1691. The remainder of the choroid coat and iris of the same eye.

1692. The optic nerve and a longitudinal section of the sclerotic coat of the eye of the Bottle-nose Whale. The extreme length of the nerve depends on the vast width of the head as compared with that of the brain. The section of the sclerotic shows the posterior canal for the passage of the nerve.

1693. A longitudinal section of the eye of a Grampus (*Delphinus Orca,* Linn.), in which it may be observed that the posterior aperture of the sclerotic is of a more infundibular figure than in the preceding species, the softer substance being continued around the nerve to near its termination in the retina. The greenish tinge of the choroid is also more obvious in this than in the preceding preparations. The cornea, retina, and humours have been removed.

1694. The tunics of the eye of a Seal (*Otaria,* Peron). The cornea and a longitudinal section of the sclerotica have been removed, showing the extended tapetum, which is not limited to the under side of the back part of the eye as in those quadrupeds that move the upper eyelid principally, but is continued of nearly equal breadth all round the entrance of the optic nerve, a disposition which is in accordance with the uniform expansion of the aperture of the circular eyelid by which light is admitted to the eye in this tribe, and which is found associated with a similar form of eyelid in the Cetaceans. On the part of the choroid which is reflected from the cavity of the globe, may be observed the broad ciliary zone, the large and deep ciliary processes, and the converging striæ of the uvea. The cut edge of the sclerotica shows the great thickness of its anterior and posterior parts, and the sudden thinness of that part which corresponds to the base of the ciliary zone. This structure is regarded by Blumenbach*, with great probability, as having a relation to the faculty of seeing in two different mediums which the Seal must possess.

b. Eyes adapted for seeing in Air.

8. *In Reptiles.*

1695. The eye of a Chameleon (*Chamæleo planiceps*, Merrem) transversely divided: in the posterior hemisphere may be observed the termination of the optic nerve, the expansion of the retina, and the transparent spot, 'macula centralis' or 'foramen of Sœmmerring', which is situated on the nasal side of, and a little above, the termination of the optic nerve. The sclerotica is so thin in this segment of the eye that the dark pigment of the choroid appears through it; on the anterior segment it becomes thicker, especially towards the insertion of the cornea, which is small and prominent: the crystalline lens is nearly spherical.

1696. The posterior segment of the eye of a Chameleon, showing the termination of the optic nerve, and the remarkably distinct fold of the retina, upon which is situated the transparent 'macula centralis'.†

1697. The eye of the same species of Chameleon, from which a lateral section of the coats has been removed, showing the relative thickness of the sclerotica, which is soft and flexible posteriorly, but assumes a cartilaginous structure where it supports the cornea. The crystalline lens is seen *in situ.*

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* "In the eye of the Greenland Seal the cornea was thin and yielding: the anterior segment of the sclerotica, or that which is immediately behind the latter membrane, was thick and firm; its middle circle thin and flexible; and lastly the posterior part very thick, and almost cartilaginous. The whole eyeball is surrounded with very strong muscles, and we can easily understand how their action, varied according to circumstances, produces the requisite changes; how the axis of the eye is shortened, when the animal sees in the air, by bringing the lens nearer to the back of the globe, in order to obviate the strong refraction which the rays of light experience in passing from their medium of air into the thicker one of the eyes, and *vice versâ*." (Lawrence's *Blumenbach, Manual of Comp. Anat.*, 2nd edit. p. 289.)

† See an especial account of this structure in the eyes of Reptiles by Dr. Knox. *Wernerian Trans.* v. pp. 1. and 104.

1698. The eye, eyelids, and surrounding integument of the eye of a Chameleon, in which the eyeball is laid open as in the preceding specimen, but the lens is removed. The integument is reflected forwards, showing its line of attachment to the anterior part of the eyeball, which is therefore accompanied in its motions by the eyelids; these, however, are separated from the cornea anterior to the above line of attachment by a conjunctival cavity, and have an independent motion in front of the eye.

1699. The anterior segment of the eye of a Chameleon, showing the thick choroid, the shining iris, and the pupil. A portion of one of the eyelids has been removed, exposing the conjunctival cavity anterior to the choroid.

9. *In Mammals.*

a. *Retina.*

1700. A Human eye, from which the sclerotic and choroid coats have been removed as far as they cover the retina, showing the external surface of the entire expansion of the optic nerve.

1701. An eye, from which the cornea and anterior part of the sclerotica, with the ciliary zone, iris, and humours, have been removed, showing the internal surface of the retinal expansion lining the dark choroid.

1702. A section of the posterior part of a Human eye, showing the thick fibrous sheath of the optic nerve, and the contraction of its extremity where the nervous matter passes through the cribriform disc of the sclerotica to form the retina.

1702 A. The posterior part of the Human eye, showing the *macula centralis* of the retina. *Presented by Sir Everard Home, Bart.*

1702 B. A similar preparation. *Presented by Sir Everard Home, Bart.*

1702 C. The posterior part of the eye of a Monkey, showing the *macula centralis retinæ.* *Presented by Sir Everard Home, Bart.*

1703. The eye of a Hog (*Sus Scrofa*, Cuv.), similarly prepared, to show the expansion of the optic nerve, but from which one half of the retina has been removed, showing the smooth, shining, chocolate-coloured choroid beneath.

b. Humours.

1704. A section of the anterior part of the eye of an Ox (*Bos Taurus*, Linn.), showing the crystalline humour in its capsule, with the attachment of the ciliary processes to the adventitious capsule formed by the hyaloid membrane. Portions of the iris, of the membrane of the aqueous humour and cornea are also preserved.

1705. The crystalline lens and capsule of an Ox, showing that the lens is composed of two segments of unequal spheres.

1706. Portions of the two eyes of a Slender Lemur (*Stenops gracilis*, Illig.). The upper one shows the large and prominent cornea,—large to allow of the admission of as much light as possible, and convex to adapt the vision of this nocturnal species to the small distances at which the gloom of night renders its prey visible to it. A portion of the sclerotica has been removed, showing its thin texture and the uniform dark brown colour of the choroid: the humours of the eye have also been removed. The middle portion includes a zone of the sclerotica, and choroid, and the iris; the latter is of large extent, corresponding to the size of the choroid; the pupillary aperture is circular. The crystalline lens, which is very convex, as in all nocturnal animals, is supported on a transparent glass bead of a similar form.

1707. The eye of a Flying Squirrel (*Pteromys Petaurista*, Desm.) transversely divided, showing the almost spherical lens *in situ*, and the large convex cornea.

1708. The entire globe of the eye of the same animal, in which the proportional magnitude of the cornea in this nocturnal species is more satisfactorily shown.

1709. The eye of the Spotted Cavy, or Paca, (*Cœlogenys subfusca*, F. Cuv.). The sclerotica is transversely divided; with the anterior moiety are preserved the large convex cornea, the correspondingly broad iris, and the ciliary processes; the pupil is round; below these parts is suspended the lens, which is very large and convex.

c. Tunics.

1710. The eye of a Lion (*Felis Leo,* Linn.) minutely injected by the ciliary arteries, and the sclerotic coat transversely divided, and reflected from the choroid to show the vascularity of that tunic. (Much of the injection appears to have been extravasated.)

1711. The two eyes of a Boar (*Sus Scrofa,* Linn.) minutely injected by the ciliary arteries and the vorticose veins. The upper eye in the bottle is transversely divided, and the humours with great part of the retina have been removed to show the vascularity of the choroid, which is not here obscured by extravasation. In the lower specimen the sclerotica has been transversely divided and reflected, and the peculiar course of the vorticose veins is beautifully displayed.

1711 a. The choroid tunic of the eye of a Sheep (*Ovis Aries,* Linn.), with the short ciliary arteries injected with mercury.

Presented by Wm. Lawrence, Esq., F.R.S.

1711 b. The tunics of the eye of a Horse minutely injected, cut open transversely and inverted, showing the arteria centralis retinæ, the vascularity of the choroid, and especially that of the ciliary processes, the forms and disposition of which are well displayed in this preparation. *Mus. Heaviside.*

1712. The sclerotic and choroid tunics of the Human eye, transversely divided, and separated so as to show the internal surface of the choroid, with the ciliary zone, ciliary processes, and iris.

1713. A similar preparation, in which the ciliary processes are seen in beautiful contrast with the uvea or pigment covering the back part of the iris.

1714. Preparations of the two eyes of a ‘dark Person’. From the upper one a longitudinal section has been removed, showing a portion of the coagulated and collapsed retina in relief against the dark-coloured choroid. In the lower specimen the sclerotica and cornea have been dissected off, exposing the anterior part of the choroid and the iris, which correspond in colour, but are separated by the paler intermediate ciliary zone: the ciliary nerves are well displayed upon the dark choroid.

1715. The eye of a 'dark Person', with the sclerotica transversely divided and reflected from the choroid to show the dark colour of the latter corresponding with the general complexion of the individual.

1716. The tunics of the eye of a 'Negro' transversely bisected: the dark colour of the uvea is especially remarkable.

1717. The posterior part of the sclerotic, with a portion of the choroid of a 'Gentoo'.

1718. "Two eyes from two Children; the upper one is of a white child, the lower one of a black, to show the difference in the colour of the nigrum pigmentum."

1719. "Two eyes: the upper one is of a fair person, the other of a swarthy person, to show that the nigrum pigmentum is darker or lighter in the same degree with the hair and the rete mucosum."

1720. A similar preparation, but the eye of the 'fair Person' is the lowest in the bottle.

1721. The eye of a 'fair Person', from which a lateral section of the coats and the whole of the humours have been removed, to show the light-coloured choroid.

1722. The anterior segment of the coats of the eye of a 'fair Person', with the cornea cut away to show the light blue colour of the iris, from the posterior part of which the uvea has been removed.

1723. Two Human eyes, in both of which the sclerotica is transversely divided and everted to show the choroid, which is remarkably thin, colourless, and transparent, especially in the lower specimen.

1724. A longitudinal section of the coats of the Human eye, showing a similar condition of the choroid, but there may be observed to be a light brown pigment upon the ciliary processes and the back of the iris forming the uvea.

1724 A. The eye of a Human Albino, from which a portion of the sclerotica is reflected to show the thin, colourless, and almost transparent choroid; the vascularity of which, being unobscured by the usual pigment, occasions the pink colour observable in the eye of these persons during life.

Presented by Jos. Henry Green, Esq., F.R.S.

1725. Two eyes, one of a black Rabbit, the other of a white one, prepared to show the colour of the choroid pigment, corresponding in each with the colour of the hair.

1726. An anterior and a posterior section of the eyes of a ‘Horse, foaled of a white cream colour’, showing that the pigment is white, excepting on the ciliary processes, and upon those which form the fringe descending from the upper margin of the iris, where it is of a light brown colour. In the lower section the cornea has been removed to show the white colour of the anterior surface of the iris.

1727. The posterior part of the tunics of the eye of a Horse, injected, but showing the broad transverse semilunar tapetum of silvery green pigment at the back part of the choroid, below the insertion of the optic nerve.

1728. A similar preparation of the eye of an Ox, showing the broad transverse tapetum lucidum.

1729. A similar preparation of the eye of an Antelope, showing the blue tint of the tapetum lucidum.

1730. A similar preparation of the eye of a Lion (*Felis Leo*, Linn.), showing the broad patch of tapetum lucidum below, and also a little above, the insertion of the optic nerve.

1731. The eye of a Lion divided longitudinally and horizontally, showing that almost the whole of the tapetum is confined to the lower moiety. The humours and retina have been removed from both sections; the ciliary processes are well displayed.

1732. The tunics of the eye of a Lion, from which a longitudinal section has been turned down, to show the tapetum.

1733. The tunics of the eye of a Leopard (*Felis Leopardus*, Linn.) transversely divided, showing the semilunar patch of tapetum lucidum below the termination of the optic nerve.

1734. The posterior part of the tunics of the eye of some large quadruped, showing the tapetum similar in its form and position to that of the Lion; but the sclerotica is much thicker than in any of the large 'Feles.'

Most of the preceding preparations demonstrating the pigment and tapetum in different animals, are alluded to or described by Mr. Hunter in the following observations "On the Colour of the Pigmentum of the Eye in different Animals."

"In the eyes of all animals which I have examined, there is a substance approaching to the nature and appearance of a membrane, called the pigmentum, which lines the choroid coat, and is somewhat similar to the rete mucosum which lies under the cuticle of the human body; and there is also some of the same kind of substance diffused through the cellular membrane, which unites the choroid with the sclerotic coat. My intention, at present, is only to communicate the observations I have made on this subject, and its use, confining myself to the consideration of that kind of it which lines the tunica choroides of the class Mammalia, and of birds; in doing which I shall also take occasion to speak of the difference of colour occurring in animals of the same species.

"..... The colour of the pigmentum of the eye always corresponds, I believe, with that of the hair and skin, especially if the animal be only of one colour, but is principally determined by the hair; and the most general colour is a very dark brown, approaching to black, from whence it had the name, nigrum pigmentum. The colour differs in different classes of animals, often in the same class, and even in the same species. In the Human it is most commonly dark; in the Ferret-kind always light: and its difference of colour in the same species is evident from the variety observable in the eyes of different people. There is even a difference of colour in the same eye in many classes of animals; in all of the Cat and Dog kind; and perhaps in most part of the granivorous. In some it is partly black, and partly of the appearance of polished silver; and in many classes the variation from dark is of two colours; for in the Cow, in

Sheep, Deer, Horses, and I believe in all animals feeding on grass, there are in the same eye certain portions of it white, and others of a fine green colour. The difference in colour of this pigmentum, in the eyes of different animals of the same species, is very remarkable; in the Human species it is of all the different shades between black and almost white; and the same variety is seen in Rabbits, Mice, Crows, Blackbirds, &c., but in these it is of one colour only in the same eye.

"..... The Human species is a striking example of the colour of the pigmentum corresponding with that of the skin and hair; and though the skin and hair of one person differ very considerably from the skin and hair of another, yet it is not in so great a degree as in many animals. There are cattle perfectly white, white Sheep, white Dogs, white Cats and Rabbits; but there are few of the Human species that we can say are perfectly white. They rather pass from the black into the brown, red, and even light yellow; and we find this pigmentum, although only of one colour, varying through all the different corresponding shades. In the African Negro, the blackness of whose hair and skin are great distinguishing characteristics, this pigmentum is also very black. In the Mulatto, who has not the skin so dark as the African, but the hair nearly as black this pigmentum is of a shade not quite so deep, yet still it does not approach so near to the middle tint as the skin, rather following the colour of the hair. In people of a swarthy complexion, as Indians, Turks, Tartars, Moors, &c., we find the hair always of a jet black, and this substance of a much darker brown than in those that are fair. In those of very dark complexions, and having very black hair, although descended from fair parents, the same thing holds good.

"..... In people remarkably fair, whether they are of a race that is naturally so, or what may be called monstrous in respect to colour, as white Æthiopians, still we find this pigmentum following the colour of the skin and hair; being in some of a light brown, and in others almost white, according to the colour of the hair in such people.

" All Foals are of the same colour; and whatever that may be, as they grow older it generally becomes lighter; therefore the pigmentum in them is almost always of the same colour, and does not seem to change with the hair. This change, however, is only in the hair, and not in the skin; the skin of a white or grey Horse being as dark as the skin of a black one: yet there is a cream-coloured breed which has the skin of the same colour, whose foals are also of a cream colour; and by inspecting the parts not covered with hair, such as the mouth, anus, sheath, &c., these, and the pigmentum of the eyes of such horses, are found of a cream colour likewise.

" In the pigmentum of the Rabbit kind there are all the degrees of dark and light corresponding with the colour of the hair; yet there seem to be exceptions to this rule in some white Rabbits with black eyes, and therefore with black pigmentum; but in all such there is either a circle of black hair surrounding the eye, or the eyelashes, and the skin forming the edge of the lid is also black. In many white cattle this is also observable; and in that breed of Dogs called Danes, some have the hair surrounding one eye black, while the hair surrounding the other is white; and the iris of the one is often lighter than that of the other. This circumstance, of the iris of one eye being lighter in colour than that of the other, is a common thing in the human species; and sometimes only one half of the iris is light, without any difference in the colour of the eyelash or eyebrow. Whether this difference in the colour of the iris of the two eyes, in the same animal, is owing to the pigmentum being different in colour, I do not know; although I rather suspect it is something similar to the white iris in Horses, which makes them what is called wall-eyed.

" The variation of colour appears most remarkable when a white starts up, either where the whole species is black, as in the Crow or Blackbird; or where only a certain part of the species is black (but permanently so), as a white child born of black parents; and a perfectly white child whose hair is white, and who has the pigmentum also white, though born of parents who are fair, should as much be considered as a play of Nature as the others. All these lusus naturæ, such as the white Negro, the pure white child of fair parents, the white Crow, the white Blackbird, white Mice, &c., have likewise a white pigmentum corresponding with the colour of the hair, feathers, and skin.

" Besides the circumstance of animals of the same species differing from one another in colour, there are some distinct species which are, as far as we know, always of a light colour, and in them too this pigmentum is white : the animal I allude too is the Ferret.

" When the pigmentum is of more than one colour in the same eye, the lighter portion is always placed at the bottom of the eye, in the shape of a half-moon with the circular arch upwards ; the straight line or diameter passing almost horizontally across the lower edge of the optic nerve, so that the end of the nerve is within this lighter-coloured part, which makes a kind of semicircular sweep above it. This shape is peculiar to the Cat, Lion, Dog, and most of the carnivorous tribe ; in the herbivorous, the upper edge being irregular ; in the Seal, however, the light part of this pigmentum is equally disposed all round the optic nerve, and is, on the whole, broader than it is commonly found in quadrupeds. How far this increase of surface is an approach towards the Fish kind, in which it is wholly of this metallic white, I will not pretend to say ; but it is probable, as the animal is to see in the water as well as in the air, that it may be formed circular, the better to correspond with the form of the eyelids, which open equally all round ; which seems to accord with what is observable in Fishes, they being without eyelids.

" The colour of the pigmentum, whether white or green, or both, has always a bright surface, appearing like polished metal ; which appearance animal substance is very capable of taking on, as we see in hair, feathers, silk, &c."—*Observations on certain Parts of the Animal Œconomy*, 2nd edit., p. 243.

1735. The anterior segment of the tunics of the Human eye, showing the ciliary zone and iris, the circular pupil, and the small cornea.

1736. A similar preparation of the eye of a Monkey, showing the same form of the pupil. The characteristic difference of this eye is the dark colour of the conjunctive membrane external to the cornea.

1737. A similar preparation of the eye of a Horse, showing the transversely oblong pupil, and the processes appended to the upper part of the free margin of the iris.

1738. A transverse section of the tunics of the eye of a large Quadruped, with the membrana Ruyschiana minutely injected, showing a broad ciliary zone, a narrow iris, with a circular pupil; a flaccid and somewhat flattened cornea, exterior to which there is a zone of dark-coloured conjunctiva. The sclerotica is of great thickness at the back of the eye.

1739. The tunics of the eye of an Elephant (*Elephas Indicus,* Cuv.) longitudinally divided, showing the different degrees of thickness of the sclerotica at different parts of the eye, and especially the dense substance which surrounds the termination of the optic nerve, as in the Cetacea. An affinity to the latter tribe is again shown in the extent and colour of the tapetum lucidum, notwithstanding the different circumstances under which vision is exercised. The cornea is thick and flaccid, but more convex than in the Cetacea: the optic nerve is of great length.

1740. A longitudinal section of the sclerotic coat of the Human eye, showing its anterior and posterior perforations, and its different degrees of thickness at different parts; the preparation is suspended by the optic nerve.

1740 A. The anterior layer of the cornea dissected off, with the tendons of the four recti muscles, which are dried and preserved in oil of turpentine. This preparation is figured in the Philosophical Transactions for the year 1795, Plate I., in illustration of the Croonian Lecture for that year, in which it is described by the Donor.

Presented by Sir Everard Home, Bart.

10. *In Birds.*

a. Retina and its appendages.

1741. The head of an Eagle, with the eyes *in situ.* In the left eye the anterior part of the tunics and the humours have been removed to show the retina expanding from the oblique line by which the optic nerve terminates, and the vascular processes of the 'marsupium' extending forwards from the centre of the optic fissure. In the right eye a lateral section of the coats has been removed, together with the humours and a great part of the retina, showing the uniformly dark-coloured choroid, the thin but dense texture of the sclerotica, and the zone of osseous plates which supports the projecting cornea. The 'marsupium' is preserved *in situ.* It is of an unequal quadrilateral figure, broadest below, and extending upwards and inclined a little backwards, with a slight convexity towards the nasal side of the eyeball. The large size of the eyes is worthy of notice.

1742. A longitudinal section of the eye of an Eagle, showing the oblique manner in which the optic nerve perforates the sclerotica, and its extended termination, from which the retina expands in a plicated manner: only the folds at its origin are here preserved. The parts being minutely injected, the vascularity of the choroid is shown; also the breadth of the ciliary zone, the breadth and thickness of the bony imbricated hoop surrounding the base of the cornea, the thickness of the cornea itself, and the large size of the anterior chamber of the eye.

1743. The eye of an Eagle, with a portion of the coats removed from one side, showing the folds of the marsupial membrane, from which the colouring matter has been removed.

1744. The eye of an Ostrich (*Struthio Camelus*, Linn.) transversely divided, showing in the posterior segment the expansion of the retina from the oblique extended fissure by which the optic nerve penetrates the sclerotica; the marsupium advancing forwards from the same fissure, and attached by a portion of the hyaloid membrane to one side of the back part of the capsule of the lens, which is here preserved. On the anterior segment may be observed the broad ciliary zone, the iris, and circular pupil, and the convex cornea supported by the circle of osseous plates. The muscles of the membrana nictitans, afterwards to be described, are left attached to the back part of the posterior segment of the eye.

1744 a. A section of the posterior part of the coats of the eye of the Emeu (*Dromaius ater*, Vieill.), showing the expansion of the retina, and the attachment of the marsupium to the terminal line of the optic nerve. The marsupium consists of five broad folds of vascular membrane, covered with a pigment corresponding in colour to that of the choroid coat: the folds converge towards the anterior extremity of the marsupium, which has the form of a flattened and truncated cone. *Prepared by Mr. Clift.*

1744 b. A similar preparation from the opposite eye of the same Emeu: two folds of the marsupium have been cut off near their bases, which shows their breadth and mode of plication. A part of the hyaloid membrane and capsule of the crystalline lens remains attached to the apex of the marsupium in both preparations. *Prepared by Mr. Clift.*

1745. The eyes of a Crow (*Corvus Corone,* LINN.), minutely injected. In the upper specimen the eye is longitudinally divided, and the humours removed, so as to show the oblique passage of the optic nerve through the sclerotica, and its extended termination giving origin to the marsupium and the retina; both these parts are displayed in the lower section of this eye: the retina has been removed from the other section, showing the vascularity of the choroid and ciliary processes; that of the ciliary zone is obscured by the adherent pigment.

In the lower eye a portion of the sclerotica and choroid have been removed to show the outside of the extended termination of the optic nerve, and the plicæ of the retina radiating from that part: a portion of the cornea has also been dissected off in order to expose to view the pale vascular iris and the round pupil.

1746. The eyes of a Crow. The cornea has been cut away from the upper specimen, showing the iris of a darker colour than in the preceding preparation*. Portions of the sclerotica, choroid, and retina are removed from the back part of the globe, showing the extended but narrow base of the marsupium, and its apex sunk in the vitreous humour. The lower eye is laid open to show the relative position of the marsupium and crystalline lens, and the flattened form of the latter.

1747. The section removed from the last-described eye, including portions of the retina, choroid, and its appendages, and sclerotica.

1748. The eye of a Turkey (*Meleagris Gallo-pavo,* LINN.), with a portion of the tunics removed from one side to show the crystalline lens suspended by means of the vitreous humour and hyaloid membrane to the marsupium, the vascularity of which is demonstrated by a successful injection. The basis of the marsupium is extended to nearly the semidiameter of the eye, and its breadth is much greater than its length. The colour of the pigment is seen through the sclerotica in consequence of the thinness of that tunic.

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* In the oldest manuscript Catalogue a preparation marked *a.* No. 11. is described as "the eye of a black and of a white Crow, to show that the nigrum pigmentum is darker or lighter in the same degree with the rete mucosum."

b. Humours.

1749. The vitreous and crystalline humours of the eye of the Great Horned Owl (*Bubo maximus*, Cuv.), prepared to show that the vitreous humour has a distinct capsule, part of which is reflected from its outer surface. The vitreous capsule is more easily demonstrated in Birds than in Mammals.

1750. The crystalline lens of the eye of an Owl, showing its great convexity, which is adapted to the small distances at which objects are visible to this nocturnal bird at the time when it goes in quest of food.

1751. A longitudinal section of the crystalline lens of an Owl, showing its form and laminated texture.

1752. The crystalline lens of a White Thrush.

c. Tunics.

1753. A longitudinal section of the tunics of the eye of a White or Albino Thrush, showing the absence of the pigmentum nigrum.

1754. The anterior part of the coats of the other eye of the same Bird, showing the absence of the colouring matter of the iris.

1755. The eye of the Great Horned Owl, from which the cornea, humours, and a lateral section of the tunics have been removed, showing the remarkable prolongation of the anterior segment of the eye, which assumes in consequence a tubular form. The horny plates of the sclerotica are coextended with this segment to maintain its peculiar shape, and to afford a firm basis for the support of a very large and prominent cornea. The marsupium may be observed to be of small proportional size, consisting of seven slightly converging plicæ. The sclerotica forming the posterior segment of the eye is very thin.

1755 A. A section of the sclerotica, sclerotic bony plates, and cornea of an Ostrich, with the internal lamina of the cornea reflected, and the fibrous substance which is continued from it to the bony plates left attached to its outer margin. This substance has been considered to be muscular, and to perform the function of shortening the axis of the eye for near vision by drawing back the cornea in the same manner as the radiated fibres of the diaphragm pull down the tendinous centre.

Prepared by Mr. Clift.

1755 B. A similar section of the eye of an Ostrich, with the ciliary zone and iris detached from the ciliary ligament, and turned down to show the supposed muscles of the cornea. *Prepared by Mr. Clift.*

1755 C. A similar section of the eye of a Turkey, prepared with the same view*.

Prepared by Mr. Clift.

B. *APPENDAGES OF THE EYEBALL.*

11. *In Gastropods.*

1756. A Snail (*Helix Pomatia,* LINN.), with the posterior tentacles or horns extended, showing the eye-specks, or ocelli, situated at the side of the extremity of each horn. In this position, although destitute of appropriate muscles, the eyes have the advantage of all the mobility with which the tentacle itself is endowed; and by the admirable construction of the same part they are defended from external injury by being retracted and inverted, together with the extremity on which they are supported, within the cavity of the tentacle, as in a sheath.

12. *In Cephalopods.*

1757. "The skin of the animal in the Cuttle-fish, serving for eyelid and cornea." The transparent portion is partially defended by a slight fold of the common integument, and is perforated by a small aperture which serves as the excretory outlet of the fluid contained in the cavity surrounding the eyeball.

13. *In Fishes.*

1758. The head of a Mackerel (*Scomber Scombrus,* LINN.), showing that the eye is partially defended by two vertical folds of the common integument: these are slightly raised on the right side by the interposition of a bristle between them and the globe of the eye.

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* See Crampton in Thomson's *Annals of Philosophy,* March, 1813.

1759. The head of a Herring (*Clupea Harengus*, Linn.), showing a similar provision for the defence of the eyeball and orbit. The vertical folds are unprovided with any muscular structure for their movement, and are consequently transparent, so as not to interfere with vision when the front of the eye is brought beneath them. It is worthy of observation, that where the folds decussate one another at their inferior extremities, the anterior one overlaps the posterior; so slight an impediment to progressive motion as the contrary position would have occasioned having thus been foreseen and avoided.

1759 a. The eyeball of a Cod-fish (*Gadûs Morrhua*, Linn.), prepared to show its muscles. These consist of four straight muscles (*rectus superior, inferior, externus, internus*), and two oblique (*obliquus superior, inferior*). The eye is so suspended that the several muscles may be distinguished according to the positions indicated by their names; the oblique coming from the anterior and internal or nasal parietes of the orbit; the recti arising from the posterior part of the same cavity. The obliquus superior does not pass through a pulley, but runs in one direction from its origin to its insertion. There is no muscle analogous to the suspensorius oculi of Mammalia in the present class.

It may be observed, that although there are no moveable eyelids in the present species, nor even the motionless protective folds of integument which the preceding Fishes possess, and that although the Cod, in common with the rest of the class, is destitute of lachrymal organs, and consequently has no need of an apparatus for the involuntary movement of the eyeball to effect a due lubrication of the cornea,—yet the superior oblique, and the rectus abducens are supplied by nerves distinct from one another, and from that which supplies the rest of the muscles, and that the three series of nerves thus distributed are analogous in their origins to those which go to the same muscles in Man.

Prepared by Mr. Owen.

"The eye being an organ of sense, which is to receive impressions from without, it was necessary it should be able to give its motions that kind of direction as would permit its being impressed by objects whether at rest or in motion, or moving from object to object; and it was also necessary that there should be a power capable of keeping the eye fixed upon an object when our body or head was in motion.

" For the better understanding this action of pointing the eye towards objects under the various circumstances of vision, it will be necessary to mention, that the eye is furnished with muscles, some of which in the Quadruped, Bird, Amphibia, and Fishes, are called straight, from their being placed in the direction of, or parallel to, the axis of the eye: and two, I believe, have always been named oblique. Of the straight, some animals have more than others. There are four straight muscles common to most animals; and those which have more, have the additional muscles inserted immediately in the eyeball, on its posterior surface, and surrounding the optic nerve. The four straight muscles, which are common to all quadrupeds, pass further forwards, and are rather inserted towards the anterior surface of the eye.

" For vision, at large, it was not only necessary that the eye should be capable of moving from object to object, or of following any object in motion, but also necessary that there should be a power to keep it fixed on any one object to which the mind might be attentive; therefore the muscles are formed so as not only to be able to move the eye from object to object, but likewise to keep its point of vision fixed upon any particular one, while the eye is moving progressively with the head or body.

" This is the use of these muscles, when the parts from whence they arise are kept fixed respecting the objects the eye is pointed to; but it is often necessary, while the eye is fixed upon a particular object, that the eyeball and the head in which it is fixed should shift their situation respecting that object; and this would alter the direction of the eye, if the muscles had not the power of taking up an action that produces a contrary effect, that is, keeping the point of insertion of the muscles as the fixed point, by causing their fibres to contract according as the origins of the muscles vary their position respecting the object.

" From this mechanism we find these three modes of action produced; first, the eye moving from one fixed object to another; then the eye moving along with an object in motion; and last, the eye keeping its axis to an object, although the whole eye and the head, of which it makes a part, are in motion. From either of these motions taking place singly, or being combined, the eye is always kept towards its object.

" In the two first modes of action the origins of the muscles are fixed points respecting the object; and in the last the object becomes as it were the centre of motion, or fixed point, commanding the direction of the actions of the eye, as the north commands the direction of the needle, let the box in which it is placed be moved in what direction it may. These two first modes of action are performed by the straight muscles; for the head being a fixed point, they are capable of moving the eye up and down, from right to left, with all the intermediate motions, which, taken together, constitute a circular movement; or, when the eye is to become the fixed point, then the head itself performs the circular movement. Thence appears the necessity why the object, the axis of the eye, and the point of sensation, should all three be in the same straight line.

" But this does not take place in all movements of that whole of which the eye makes a part; for besides those which we have already taken notice of, the head is capable of a motion from shoulder to shoulder, the axis of which is through the axis of the two eyes, from the fore to the back part. It should be here observed, that for distinct vision the object must be fixed as respecting the pupil of the eye, and not in the least allowed to move over its surface.

" To prevent any progressive motion of the object over the retina of the eye, either from the motion of the object itself, or of the head in some of the motions of that part, the straight muscles are provided as has been explained; but the effects which would arise from some other motion of the head, as from shoulder to shoulder, cannot be corrected by the action of the straight muscles, therefore the oblique muscles are provided.

" Thus when we look at an object, and at the same time move our head to either shoulder, it is moving in the arch of a circle whose centre is the neck; and of course the eyes would have the same quantity of motion on this axis if the oblique muscles did not fix them upon the object. When the head is moved towards the right shoulder, the superior oblique muscle of the right side acts and keeps the right eye fixed on the object;

and a similar effect is produced upon the left eye by the action of its inferior oblique muscle: when the head moves in a contrary direction the other oblique muscles produce the same effect.

"This motion of the head may, however, be to a greater extent than can be counteracted by the action of the oblique muscles. Thus, for instance, while the head is on the left shoulder the eyes may be fixed upon an object, and continue looking at it while the head is moved to the right shoulder, which sweep of the head produces a greater effect upon the eyeballs than can be counteracted by the action of the oblique muscles; and in this case we find that the oblique muscles let go the eye, so that it immediately returns into its natural situation in the orbit. Whether this is performed by the natural elasticity of the parts, or whether the antagonist oblique muscles take up the action and reinstate the eye, I do not know. If the head still continues its motion in the same direction, then the same oblique muscles begin to act anew, and go on acting, so as to keep the eyes fixed on the object. As this motion of the head seldom takes place uncombined with its other motions, some of the straight and oblique muscles will be employed at the same time, according as the motions are more or less compounded." *Hunter, Observations on Certain Parts of the Animal Œconomy*, p. 253.

1760. The head of a Hammer-headed Shark (*Zygæna*, Cuv.), vertically and longitudinally bisected, and the muscles of the eyeball displayed. The straight muscles are of great length, in consequence of the position of the eyes at the sides of the head, which are remarkably extended in the form of broad, flattened, oblong processes. On the right side the obliquus superior, and the rectus superior, internus and externus, are displayed; on the left the obliquus inferior and the rectus inferior. The fleshy parts of the recti are only developed at a short distance from the eyeball.

1761. The left eyeball and its muscles of the Grey Shark (*Galeus communis*, Cuv.), showing their insertions: the obliqui are attached to the same protuberances of the sclerotica as the superior and inferior recti, which is the most favourable insertion for effecting the rotatory movements of the eye upon its axis: the function which is ascribed to them by the Founder of the Collection.

In addition to the muscles, there exists in this and other higher organized chondropterygious Fishes a cartilaginous pedicle, which is here attached to the back of the sclerotica immediately above and external to the insertion of the optic nerve.

1761 A. The eyeball, eyestalk, with a portion of the optic nerve and muscles, of the Basking Shark (*Selache maxima,* Cuv.), showing on a large scale the prodigious development of the moving powers. The cartilaginous pedicle is attached by a ligamentous substance to the posterior part of the sclerotica, which in some other Chondropterygians is developed into a tubercle, to which the pedicle is articulated by a true ball and socket joint provided with a synovial membrane and a capsular ligament. See Nos. 1672, 1673. *Prepared by Mr. Clift.*

1762. The circular palpebral fold of integument, with the nictitating or third eyelid of the eye (No. 1761.) of the Grey Shark. A secreting conjunctive membrane is reflected deeply between the circular fold and the globe of the eye, of which it covers the anterior half; it also forms a smooth lubricated covering, as usual, to both sides of the third eyelid; this is placed at the inferior and internal or nasal side of the orbit, and is moved over the front of the eye, in a direction upwards and outwards, by means of a strong round muscle (nictitator), which arises from the upper and posterior or temporal side of the orbit, and descends obliquely to be inserted into the lower and outer margin of the third eyelid; passing in this course first through a muscular trochlea, and then through a ligamento-cartilaginous loop. The trochlear muscle is not, however, exclusively subservient to the action of the nictitator, but has an insertion in the upper part of the palpebral fold, which it depresses simultaneously with the raising of the third eyelid: a slight external groove above the upper eyelid indicates the extent of motion of which it is susceptible in the living animal.

1763. The opposite eye, with its muscles and defensive apparatus, of the same Shark, showing the relative positions of the insertions of the different muscles, the optic nerve, the cartilaginous pedicle of the eye, and the line of reflection of the conjunctive membrane. The movements of the eyelids are here facilitated by the abundant mucous secretion of the conjunctiva, a true lachrymal apparatus not being as yet developed.

14. *In Reptiles.*

1764. The eyeball and eyelids, with their muscles, of a Chameleon. The muscles of the globe are the same in number, disposition, and function as in Fishes, but the obliqui, or rotators of the eye upon its axis, are relatively smaller than the recti. The eyelids are reflected from the anterior part of the eye, showing the extent of the conjunctiva and the small size of their external opening; they move principally with the eye, and the integument at their junction with the skin of the head is extremely thin, wrinkled, and flexible, to allow of this motion. There is no vestige of the third eyelid.

1765. A section of the head of a Chameleon, showing the circular and prominent eyelids in their natural positions.

1766. The eyeball, eyelids, and lachrymal glands of a Turtle (*Chelonia Mydas*, Brongn.). Here the upper and lower eyelids are distinctly developed, and accurately close the conjunctival cavity when moved by their appropriate muscles. There is also a well-developed nictitating or third eyelid, which is situated vertically at the inner canthus of the eye, and has a horizontal motion over the cornea: it is here slit across to show the orifice of the duct of the Harderian gland, of which the secretion is expressly destined to facilitate its movements. This gland, however, is of small size compared with the true lachrymal gland, which consists of the thick and broad conglomerate mass surrounding the outer and upper parts of the eyeball: its duct is short and wide, and terminates just above the external canthus of the eye; a portion of quill is inserted into it; a bristle is passed into the duct of the Harderian gland. The insertions of the muscles of the globe are preserved in this preparation; and the four small accessory muscles forming the ‘suspensorius’, or ‘retrahens oculi’, and surrounding the optic nerve, deserve especial notice.

1767. The eyelids, with the Harderian and a portion of the lachrymal gland, of a Turtle. The nictitating membrane is entire, and a portion of the nictitator muscle is seen attached to its inferior angle. A bristle is passed into the duct of the Harderian gland, which opens on the internal surface of the nictitating membrane, near the line of reflection of the conjunctive membrane. The under eyelid, which has most motion, may be observed to have the fewest scales upon its external surface.

1768. The three eyelids of a Turtle; the horizontal ones are separated at the external canthus, and the vertical one raised by means of bristles, to show the rugous irregular surface of the conjunctive membrane, and especially the small parallel folds at the line of its reflection upon the external surface of the membrana nictitans.

1769. A vertical section of the head of a young Crocodile, showing the three eyelids. The horizontal ones have each been divided and reflected from the front of the eyeball: the vertical or nictitating eyelid is drawn over the cornea, and a bristle placed under it, showing its extent and semitransparency.

1770. The eyeball of a Crocodile, with the eyelids, and their muscles, prepared principally to show the membrana nictitans and its muscle. The nictitator arises from the inner and upper part of the eyeball, proceeds outwards and downwards, winding round the optic nerve and suspensory muscles (which latter serve here to protect the nerve from the pressure of the nictitator muscle); and finally is inserted into the inferior angle of the nictitating membrane, which it thus draws outwards over the eyeball, while at the same time it rotates the eyeball inwards beneath the membrane; the muscle being attached to moveable points at both extremities. (See the further description of this preparation in that of the figure, engraved in Plate XLII. fig. 3.)

1771. The horizontal eyelids divided at the external canthus, showing the vertical or nictitating eyelid spread out; the Harderian gland is dissected and a bristle placed in the wide opening of its duct, which is situated at the base of the nictitating membrane on its inner surface. The parts are from the opposite eye of the same Crocodile as the preceding.

15. *In Mammals.*

1772. The anterior part of a Mole (*Talpa Europæa*, Linn.), showing the minute circular palpebral orifices, defended by the short thick fur.

1773. The eyeball and its muscles of a Porpesse (*Phocæna communis*, Cuv.). The four recti and two obliqui are exhibited; the small muscles forming the suspensorius oculi are concealed by the straight muscles. The obliquus superior rises here, as in every other Mammal, from the back part of the orbit above the foramen opticum, and the course of its fibres is changed, in order to render it a rotator of the eyeball on its axis. The part of the muscle which passes through the substance serving as the trochlea is only partially tendinous and little diminished in diameter.

1774. The eyeball and surrounding muscles, with the eyelids, of a Porpesse. The eyelids consist of a continuous circular fold of the skin, leaving a circular opening in front of the eye, with a narrow margin unprovided with cilia. The palpebral opening is closed by an orbicular sphincter, and expanded by four broad and almost continuous muscles, which are here preserved. The eyelid is divided at its internal side, showing the extent of the reflection of the tunica conjunctiva. Bristles are placed in the ducts of the larger mass of the palpebral glands, which from its situation is analogous to the Harderian gland; there is not, however, any trace of a nictitating membrane.

1775. The eyeball and eyelid of a Porpesse, minutely injected, and with the cavities of the eye and conjunctival sac laid open, showing the extent and vascularity of the latter. The Harderian gland is dissected, and a bristle inserted into one of its ducts.

1776. The eye of a Dolphin (*Delphinus Tursio*, Fabr.), showing the zone of palpebral or Meibomian glands, and the terminal orifices of their ducts, which open into the conjunctival sac at the line of its reflection from the eyeball to the eyelid; bristles are placed in these orifices. The larger mass at the inner side of the eyeball is clearly displayed, and its ducts are distinguished by the thicker bristles.

1777. A section of the circular eyelid, with the palpebral glands, of the Piked Whale. Bristles are in like manner inserted into the terminations of the Meibomian ducts.

1777 a. The eyeball and membrana nictitans of a young Dugong (*Halicore Indicus*, Cuv.). The presence of the nictitating membrane forms one of the characteristic differences between the herbivorous and carnivorous Cetacea. *Presented by Sir Everard Home, Bart.*

1778. The eyeball, circular eyelid, and membrana nictitans, of a large Seal (*Otaria*, Péron). A section of the eyeball and lid is removed from their outer side, which exposes the cavity of the eye and conjunctival sac, showing the membrana nictitans retracted at the inner canthus. The large Harderian gland at the base of the nictitating membrane is also dissected. The external groove at the inner canthus indicating the division of the horizontal eyelids in this amphibious species is worthy of observation.

1779. The vertical eyelid or membrana nictitans, with the Harderian gland, of an Elephant (*Elephas Indicus*, Cuv.): the membrane is supported by a flat, thin, slightly curved cartilage, which expands and becomes thinner as it is attached to the concave margin of the membrane. The Harderian gland is continued, as in the Cetacea, from a group of smaller mucous glands which have many excretory orifices upon the margin of the third eyelid, but its principal duct terminates upon the inner surface and close to the base of the same part.

1780. The nictitating membrane and its muscle, with the Harderian gland, of the opposite eye of the same Elephant. The fibres of the nictitator pass at first in a regular curve over the base of the membrane, but afterwards deviate from the curve and form an angle to include the extremity of the nictitating cartilage, which is consequently moved in the diagonal of the contracting forces, which push the membrane forwards and outwards over the front of the eyeball.

1781. The eyelids, conjunctive membrane, nictitating membrane, and Harderian gland of a Boar (*Sus Scrofa*, Linn.). The latter is of large size; its duct opens upon the lower part of the inner surface of the membrane; a bristle is placed in the terminal orifice. A larger bristle is passed through the punctum lachrymale of the upper eyelid: the same lid is provided with a series of stiff unequal cilia, beneath which may be observed the orifices of the Meibomian glands. The margin of the nictitating membrane is convex.

1782. The eyeball and nictitating membrane of a Dromedary (*Camelus Dromedarius*, Linn.).

1783. The eyelids and nictitating membrane of a Dromedary, showing the fatty and ligamentous substance attached to the base of the membrane.

1784. The nictitating membrane and Harderian gland of a Dromedary, showing the terminations of four ducts which convey its secretion to the base of the inner surface of the membrane: bristles are inserted into these ducts.

1785. The eyelids and nictitating membrane of a Cow. Bristles are placed in the puncta lachrymalia, and also into the ducts of some of the Meibomian glands.

1786. The eyeball, eyelids, and membrana nictitans of a small Musk-deer (*Moschus*, Cuv.). The commencement of the lachrymal duct is preserved.

1787. The eyelids, with part of the eyeball, the nictitating membrane, and Harderian gland, of a white Rabbit.

1788. A vertical section of the eyeball and eyelids of a Monkey, exposing the cavities of the eye and the conjunctival sac, and showing the dark colour of the conjunctiva, and the rudimental nictitating membrane at the inner canthus.

1789. The eyelids of a Negro. The upper one is divided, and the two parts are separated to show the white conjunctiva; the two puncta lachrymalia, into which bristles are placed; the glandular caruncula lachrymalis, and behind this the 'plica lachrymalis' or rudiment of the membrana nictitans.

1790. The eyelids of an European, separated at the external canthus.

1791. The Human eyelids in their natural connexions, and closed; injected to show the vascularity of the tunica conjunctiva: bristles are placed in the puncta lachrymalia.

1792. The Human eyelids, eyebrow, and surrounding integument. The eyelids are open, and bristles are placed in the puncta lachrymalia.

1793. The Human eyelids and surrounding integument, with the entire sac of the tunica conjunctiva, and the anterior segment of the eyeball, minutely injected, dried, and preserved in oil of turpentine. Bristles are placed in the puncta lachrymalia.

1793 A. The bones of the orbit and a portion of the nasal cavity of a Child, with the tarsi and cilia, the puncta lachrymalia, sacculus lachrymalis, and ductus ad nasum, injected with mercury: the whole dried and preserved in oil of turpentine. *Presented by Wm. Lawrence, Esq., F.R.S.*

16. *In Birds.*

1794. The eyeball and its muscles, with the eyelids, the membrana nictitans and its muscles, and the Harderian gland, of an Ostrich (*Struthio Camelus*, Linn.). Of the muscles of the eye itself, viz. the four recti and the two obliqui, only the insertions are preserved. They may be recognised by their positions. The superior oblique is remarkable for its size; it arises from the anterior part of the orbit, and consequently does not pass through a pulley, its course from its origin to its insertion being exactly adapted to produce a rotation of the eyeball upon its axis. The muscles of the nictitating membrane are two in number; one of them, called the 'quadratus nictitantis' or 'trochlearis,' is of an unequal four-sided figure, arises from the upper and outer part of the eyeball, and descends obliquely downwards and inwards towards the optic nerve, where it terminates in a free, slightly curved, tendinous margin, which is perforated by a canal for the passage of the tendon of the opposite muscle. This, which is called 'pyramidalis nictitantis' or 'nictitator,' is of a triangular form, arises from the inner and lower side of the orbit, converges as it ascends towards the quadratus, through the loop or pulley of which its tendon glides; then, winding over the optic nerve, it descends and enters a sheath in the substance of the lower part of the sclerotica, and is finally inserted into the lower angle of the free margin of the membrana nictitans, along which it is continued for some distance and is gradually lost. By the simultaneous action of the two muscles, the third eyelid is drawn rapidly and forcibly outwards, and with an oblique inclination downwards over the fore part of the eye. The tendon of the pyramidalis gains the due direction for that office by winding round the optic nerve, and it is restrained from pressing upon the nerve by the counteracting force of the *quadratus*, which thus augments the power of the antagonist muscle, while it obviates any injurious pressure on the optic nerve which its peculiar disposition in relation to that part would otherwise occasion. The nictitating membrane returns, on the relaxation of its muscles, by virtue of its own elasticity, to the inner corner of the orbit, where it lies folded up when not in use. The Harderian gland, the secretion of which is designed more especially to facilitate the movements of the third eyelid, may be observed on the nasal side of the eyeball posterior to the lower oblique muscle. Its duct winds over that muscle, and passes straight forwards, to terminate at the internal side of the basis of the nictitating membrane. The external or horizontal eyelids are furnished with stiff cilia irregularly disposed: the lower lid is most developed and has most motion. (See Plate XLII. fig. 4 to 7.)

1795. The lachrymal gland of an Ostrich, with the duct injected with mercury, dried, and preserved in oil of turpentine.

1796. The eyeball, with portions of the horizontal eyelids, the vertical eyelid or membrana nictitans and its muscles, of an Eagle. The quadratus nictitantis may be observed to have a more extensive origin than in the Ostrich, and both muscles of the third eyelid are relatively larger. The cornea is cut away, and the nictitating membrane raised, to show the termination of the duct of the Harderian gland, in which a bristle is placed. Bristles are also passed through the two puncta lachrymalia. The round and slightly concave tarsal cartilage of the lower eyelid may be observed; the upper lid has no tarsal cartilage.

1797. The three eyelids of an Eagle, showing the tarsal cartilage of the lower lid, which is raised, as in the act of closing the eyes.

1798. The eyeball, membrana nictitans and their muscles, with the external eyelids and Harderian gland, of the Great Horned Owl (*Bubo maximus*, Cuv.). In consequence of the limited motion of the eyeball, arising from its bulk as compared with the orbit, the muscles are of small size. Those of the membrana nictitans are, on the contrary, well developed. Bristles are placed in the puncta lachrymalia, and in the duct of the Harderian gland.

1799. The right side of the head of the Horn-Owl (*Otus aurita,* Cuv.), showing the three eyelids *in situ.* The two horizontal are provided with plumose cilia; the third or nictitating eyelid is more obliquely placed in the Owls than in other birds, and sweeps over the eye downwards as well as outwards, in which motion it is usually accompanied by the upper eyelid. The tarsal cartilage is nevertheless found only in the lower eyelid. A white bristle is passed through the duct of the Harderian gland, and a black one through one of the puncta lachrymalia and the lachrymal duct to the nose.

Fig. 1.

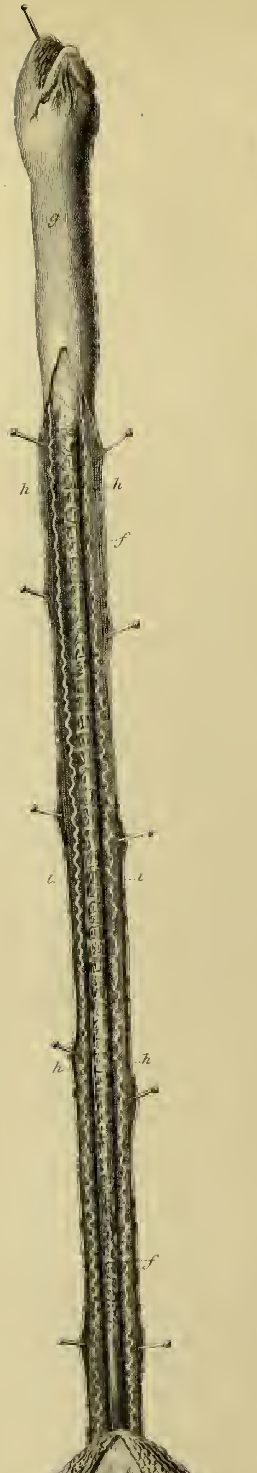


Fig. 2.

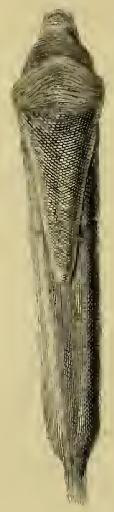
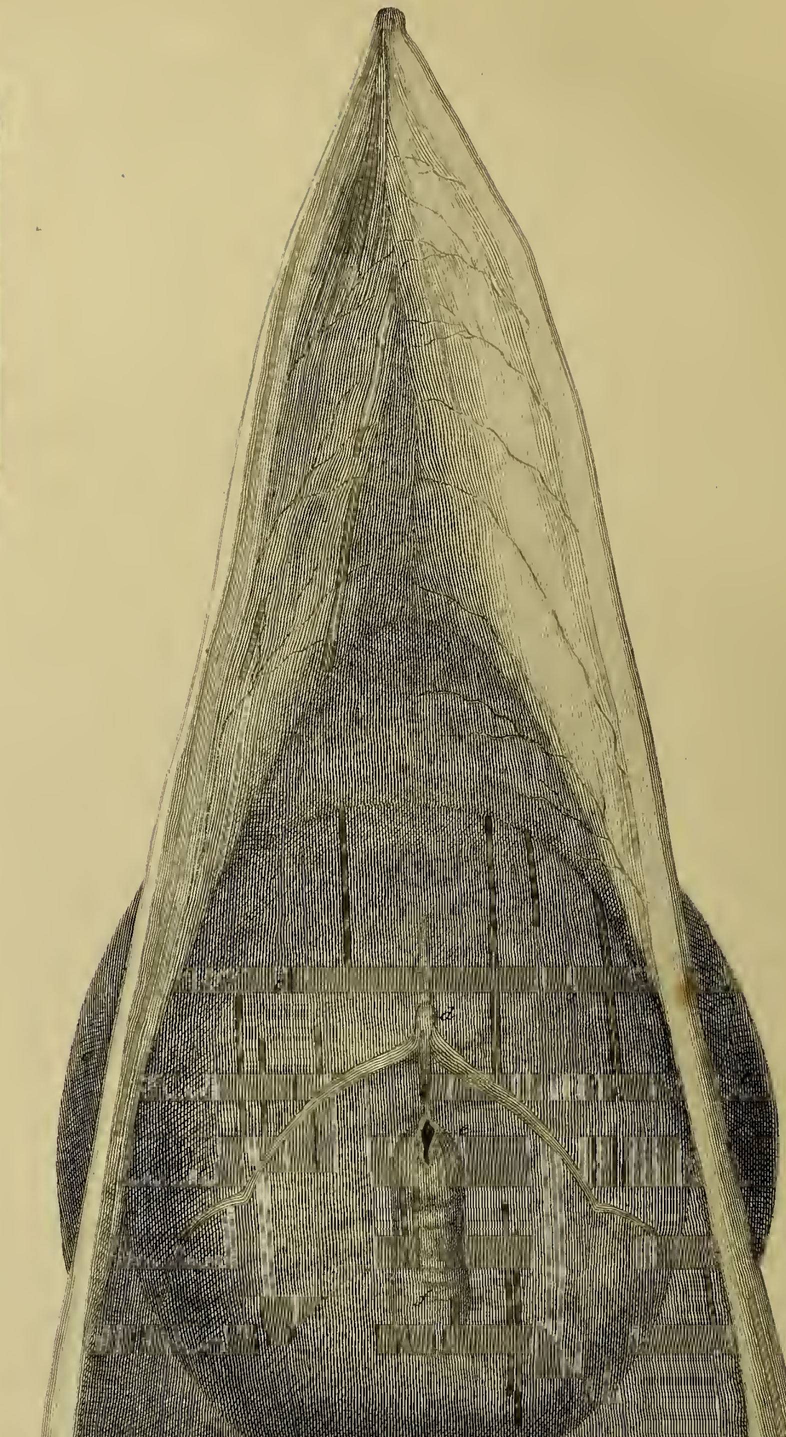


Fig. 3.



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DESCRIPTION OF THE PLATES.

PLATE XXX.*

STRUCTURE OF THE TONGUE IN THE CHAMELEON AND PELICAN.

" *Fig.* 1.* is the tongue of the Chameleon elongated, with the lower jaw, &c., and cut open to show the internal parts.

" *a,* The skin covering the lower jaw.

" *b,* The two jaw-bones, [rami of the lower jaw].

" *c,* The os hyoides, [cornua, or apo-hyals].

" *d,* The os linguale, [glosso-hyal].

" *e,* A muscle of the os hyoides, [sterno-hyoid].

" *f, f,* The elongators of the tongue.

" *g,* The bulbous part of the tongue, which is unalterable, and which is seen lying in the mouth when the tongue is contracted, and may be called the true tongue. It terminates at the end in two eminences, which probably act as the finger and thumb, or a pair of forceps.

" *h, h,* are two muscles arising from the os hyoides, which pass along the tongue, and are inserted into the bulb, spreading there, and, as it were, inclosing the elongators. Within each muscle may be observed a nerve, *i, i,* passing along in a serpentine course, beginning in the drawing at *ï, ï.*

" *Fig.* 2. is the under surface of the bulbous part of the tongue.

" *Fig.* 3.† is the lower jaw of the Pelican, with a piece of wood put between the two condyles to keep them asunder, showing the beginning of the fauces or mouth occupying the whole of the lower jaw; at the lower part of which is the opening of the larynx, with part of the trachea; as also the os hyoides seen through the membrane of the fauces."

a, a, The two bones of the lower jaw.

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* No. 6. *Manuscript Catalogue of Drawings.*

† No. 11. Plate II. *Ibid.*

b, The hollow of the fauces.

c, The swell of the fauces between the two jaw-bones.

d, The os hyoides with its two branches.

e, The opening of the larynx.

f, The trachea seen through the membrane of the fauces.

g, The œsophagus.

PLATE XXXI.

OLFACTORY ORGAN AND NERVOUS SYSTEM OF THE PEARLY NAUTILUS, AND BRAIN OF THE CUTTLE-FISH.

Fig. 1. The head and anterior muscular part of the body of the Pearly Nautilus (*Nautilus Pompilius*, Linn.), laid open from above or behind, and the nervous system displayed.

a, The cut edges of the musculo-ligamentous disc which covers the head.

b, The muscles which attach the shell to the soft parts.

c, The left external labial process ; the corresponding one of the opposite side has been removed.

d, *d*, The internal labial processes.

e, *e*, The extremities of the tubular digitations which contain the tentacles ; some of these are laid open on the right side, exposing the whole length of the tentacles.

f, The external labial tentacles.

g, The internal labial tentacles.

h, The olfactory laminæ.

i, The ophthalmic tentacle.

k, The pedicellate eye, laid open to show

l, The sclerotica.

m, The orifice in the sclerotic through which the light is admitted to the cavity of the eye.

n, The dark pigment, which lines

o, The retinal expansion of the optic ganglion.

1, The supraœsophageal ganglion or brain. It is, in the Nautilus, in the form

Fig. 3.

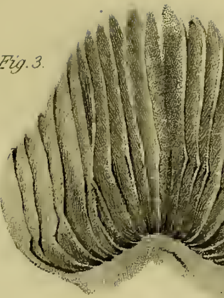


Fig. 1.

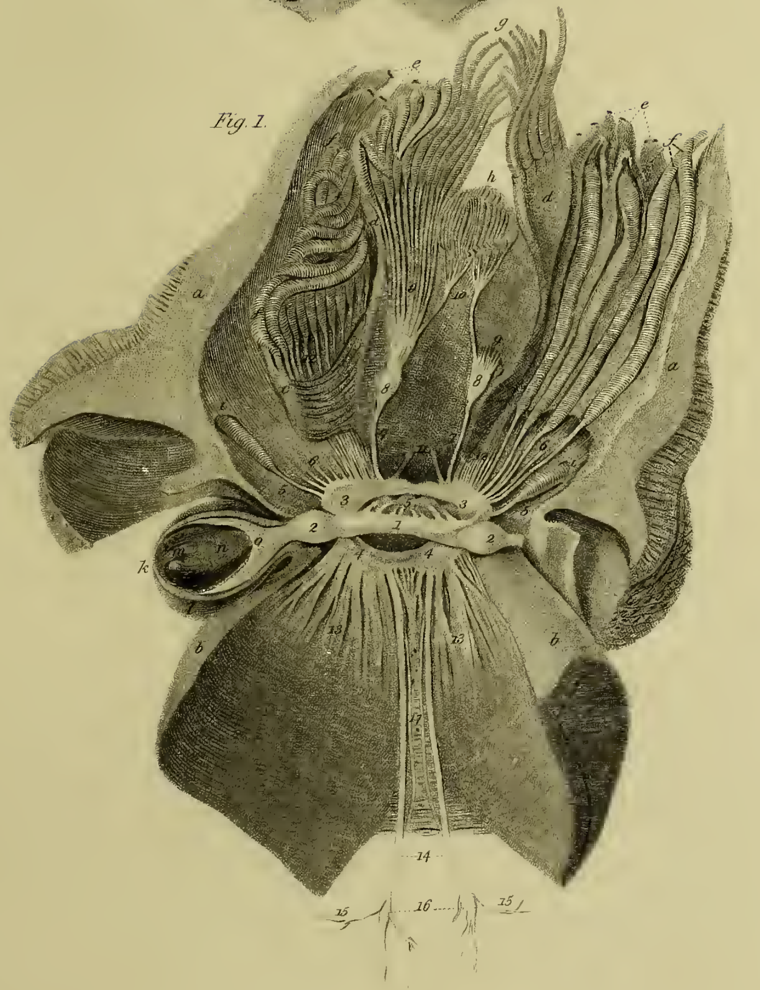
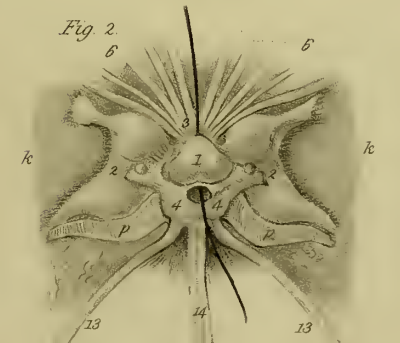


Fig. 2.



Rd. Owen, del.

Zeitter, sc.

of a simple chord or commissure, to the extremities of which are connected

2, 2, The optic ganglia.
3, 3, The anterior subœsophageal ganglia.
4, 4, The posterior subœsophageal ganglia.
5, Buccal and pharyngeal nerves.
5*, 5*, The nerves going to the ophthalmic tentacles.
6, 6, The nerves which supply the digital tentacles, and in the Cuttle-fish the acetabuligerous arms.
7, 7, The nerves passing to 8, 8, the internal labial ganglions.
9, 9, The branches to the internal labial tentacles.
10, 10, The nerves supplying the olfactory laminæ.
11, 11, The nerves which supply the infundibulum.
12, 12, The nerves of the external labial tentacula.
13, The nerves of the great muscles of attachment.
14, The nerves corresponding to the par vagum.
15, The branchial nerves.
16, The ganglions communicating with the visceral or sympathetic nerves, and supplying the heart, venous follicles, and abdominal viscera.
17, The sympathetic nerves accompanying the vena cava to the abdomen.

Fig. 2. The brain and origins of the principal nerves of a Cuttle-fish, *Sepia officinalis*, LINN.

The same figures are used as for the corresponding parts of fig. 1.

The bristle is placed in the situation of the œsophagus, around which the nervous masses are aggregated. The brain and optic or reniform ganglions are here developed in accordance with the more complex organ of vision, and the more extensive locomotive faculties of this higher organized Cephalopod. A small spherical body, probably analogous to the corpus geniculatum, is appended to the peduncle of the optic ganglion on either side.

As the supraœsophageal cerebral mass is principally in communication with, and is developed to receive the impressions transferred by the optic nerves, it must be considered as analogous to the bigeminal bodies in the brain of Vertebrata; which parts are first developed in all the higher classes, and from their constancy and magnitude in the cold-blooded Vertebrata, are evidently among the most important parts of the cerebral organ. The medulla oblongata, from which the auditory and respiratory nerves are given off, is in the Cuttle-fish situated below the œsophagus.

p, The cut surface of the cartilaginous cranium.

The ganglion stellatum from which the nerves pass to the soft vascular and sensitive external covering of the *Sepia.*

Fig. 3. A magnified view of *h,* fig. 1, the olfactory laminæ of the *Nautilus.*

PLATE XXXII.*

Fig. 1. The head of a Swan (*Cygnus Olor,* BRISSON). The upper part of the cranium is removed to show the brain, olfactory nerves, and eyeballs, *in situ.*

a, a, The hemispheres of the cerebrum.

b, The cerebellum.

c, The medulla spinalis.

All these parts are in this figure covered by the dura mater (*d, fig.* 2.).

e, The longitudinal venous sinus.

f, f, The lateral sinuses, running in the angle between the cerebrum and cerebellum.

g, g, The parietes of the skull, showing in fig. 3. the large air-cells of the diploë.

h, h, The ethmoidal and nasal cells.

i, i, The olfactory nerves.

k, k, The superior turbinated or spongy bones, which here exist in a membrano-cartilaginous state.

l, l, The external nostrils.

s, s, The eyeballs, covered by the orbital aponeurosis.

t, t, The supraorbital nasal glands. *t′,* Their duct passing to the nose; a bristle is placed in it in fig. 3. *t′.*

v, v, The Harderian glands.

Fig. 2. The brain of a Swan, exposed by the reflection of the dura mater: a part of the left hemisphere is taken away.

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* No. 97. *Manuscript Catalogue of Drawings.* These figures have no description; the several parts which they display are now named from comparisons with recent dissections.

Fig. 1.

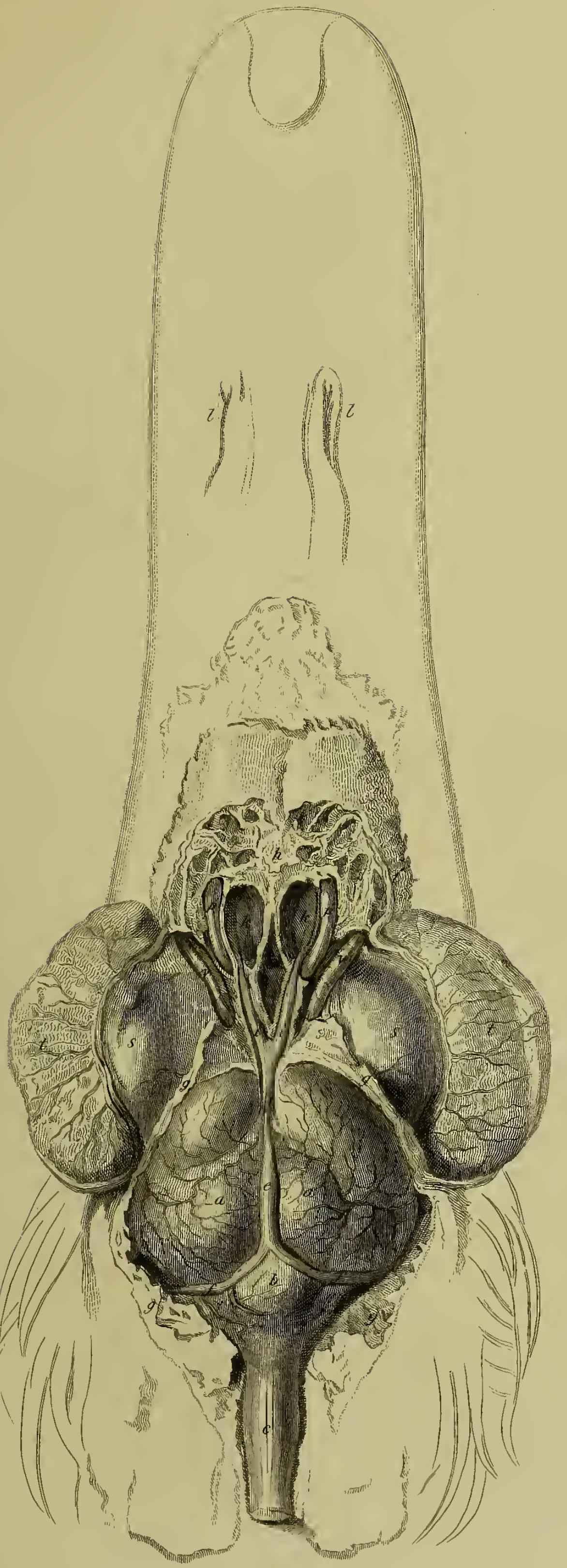

Fig. 2.

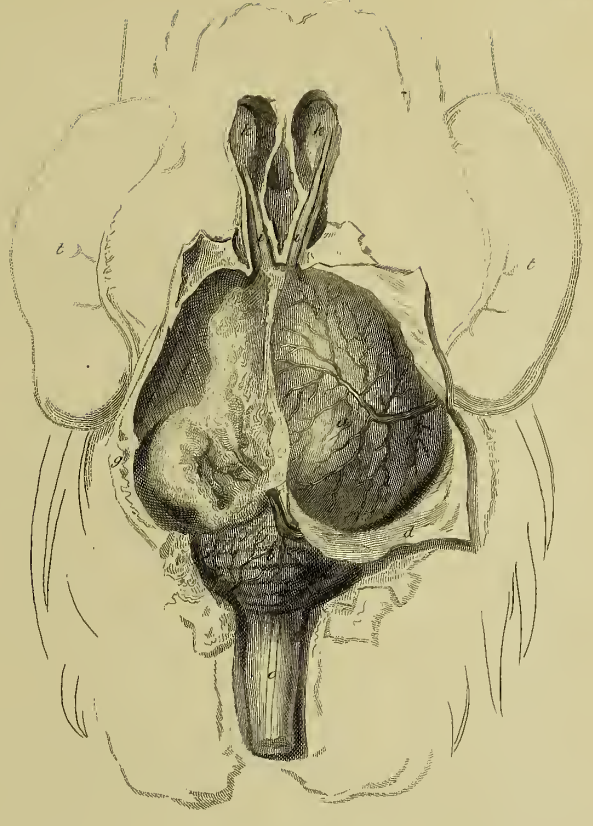

Fig. 3.

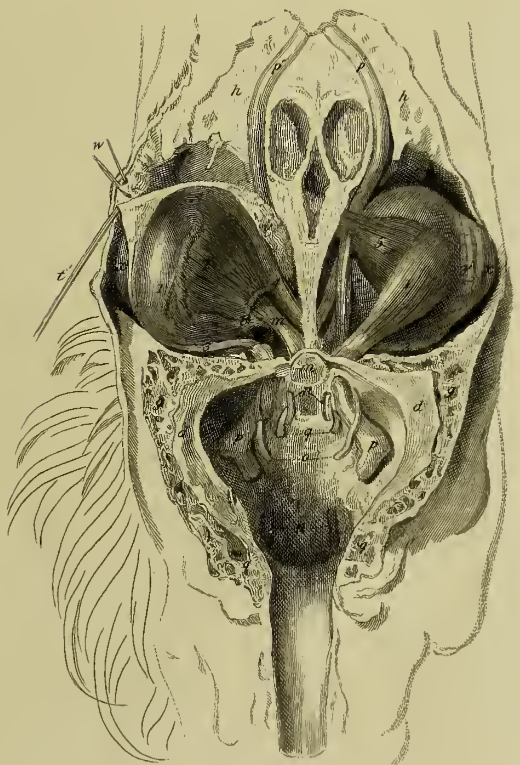

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Fig. 1.

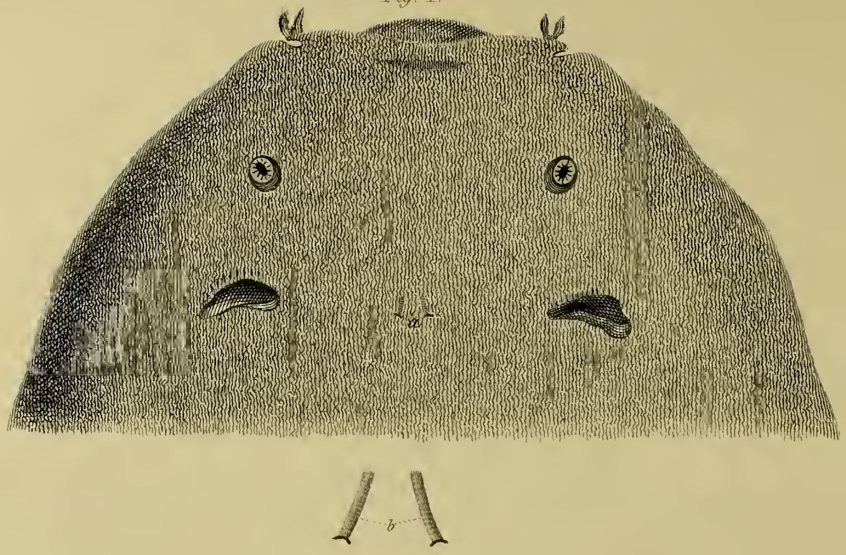


Fig. 2.

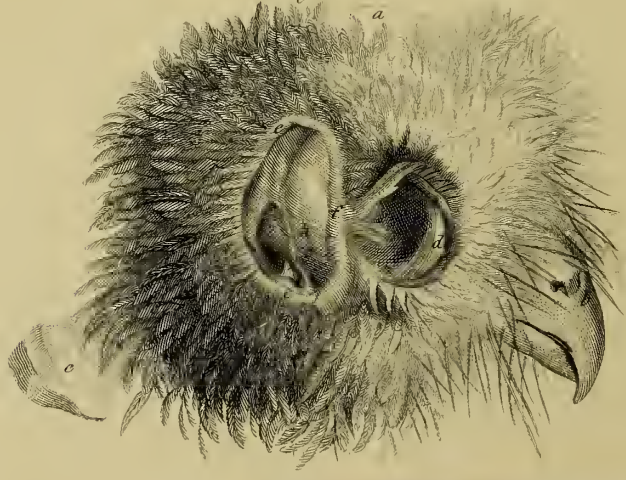
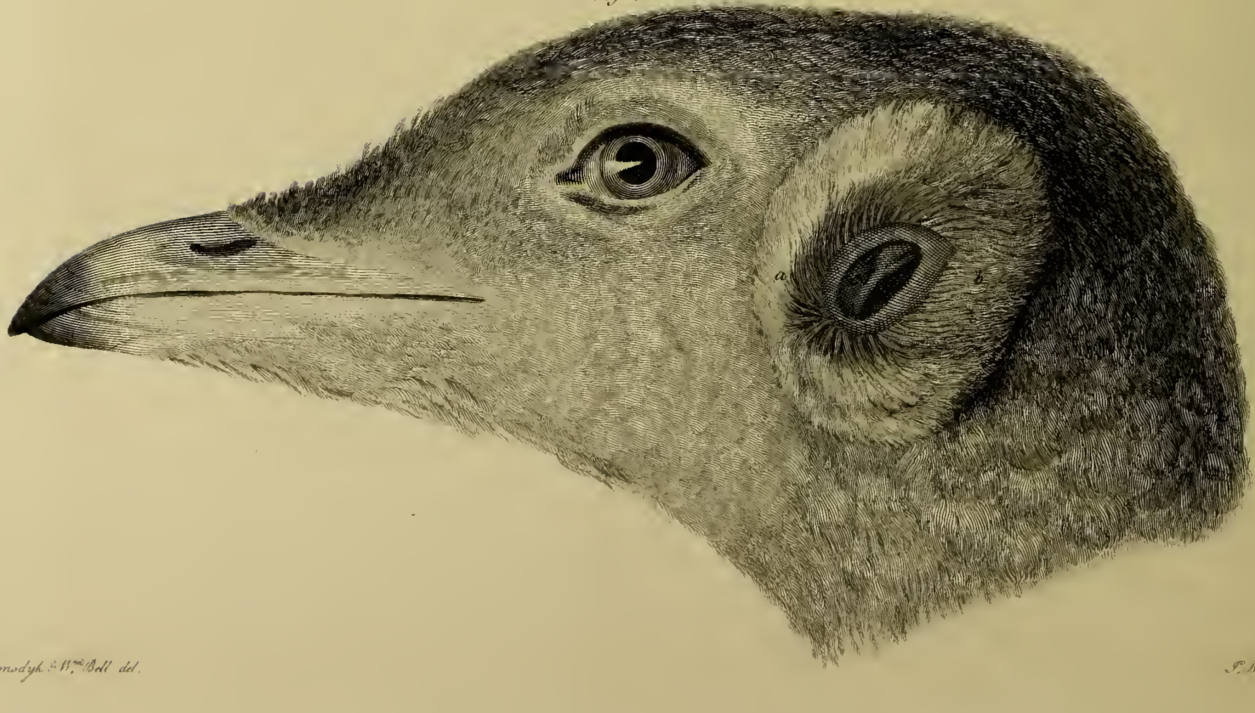


Fig. 3.



J. V. Rymsdyk & Wm. Bell del.

J. Basire sc.

a, Shows the arteries of the pia mater, *b, c.*

d, A portion of the dura mater.

The remaining letters indicate the same parts as in the previous figure.

Fig. 3. The cranium of a Swan, sawed down to the level of the optic foramen, with the brain removed, showing the exit of the principal cerebral nerves.

m, The decussation of the optic nerves horizontally divided.

The left nerve is traced to the eye.

n, The third pair of nerves.

o, The fourth pair: the right nerve is traced to the superior oblique muscle, in which it terminates.

p, The fifth pair, or trigeminal nerve. *p′, p′,* The supraorbital branch of the same nerve.

q, The sixth pair.

n, The seventh, eighth, and ninth pairs of cerebral nerves.

t′, A style introduced into the duct of the nasal gland.

v, The Harderian gland of the left eye.

w, The two puncta lachrymalia.

x, The prominent cornea, supported by

y, The sclerotic zone of bony plates.

1. The rectus superior, or attollens muscle. It is cut away on the left side.

3. The rectus externus, or abducens.

4. The rectus internus, or adducens.

7. The quadratus muscle of the nictitating membrane. Part of the tendon of *pyramidalis,* 8, is seen passing through its pulley.

PLATE XXXIII.

Fig. 1.* Anterior part of the head of a Monk-fish (*Squatina Angelus,* Dum.), showing the situation of the external openings of the ears, marked *a,* one third of the natural size: *b,* shows the exact distance between the two auditory orifices, and the slight grooves continued from them anteriorly.

* No. 104. *Manuscript Catalogue of Drawings.*

Fig. 2.[*] "Birds, as far as I know, have no projecting external ear. This appears to be only a termination of the external skin, similar to the eyelids or the mouth in the Human Subject, &c., and which is in some degree capable of being contracted or dilated. From this aperture a very short passage goes on to the membrana tympani, which can be seen in most birds. Some birds have much larger external ears than others, of which the Owl is an example." The figure is of the head of a young White Owl (*Strix flammea*, LINN.). The down is pressed backwards and forwards to expose the auditory passage and operculum.

a, The cranium.
b, The bill perforated by the nostril.
c, The neck.
d, The eye.
e, *e*, The termination of the external skin surrounding the orifice of the ear.
f, The anterior flap or opercular fold of the ear.
g, A part of the tympanic or quadrate bone.
h, The membrana tympani.

Fig. 3.[†] The head of a Bustard (*Otis tarda*, LINN.), with the auditory feathers or 'auricŭlars' spread out, so as to expose the external aperture and passage of the ear.

a, The anterior feathers pressed forwards.
b, The posterior feathers in their place.
c, The anterior surface of the external meatus.
d, The membrana tympani.

PLATE XXXIV.

"Organ of Hearing in the small Bottle-nose Whale" (*Delphinus Tursio*, FABR.).

Fig. 1.[‡] "This drawing is intended to show only the external and relative parts of the organ itself: the internal and immediate organ being situated within the bony tympanum. The head lies upon its upper surface, and the

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[*] No. 105. *Manuscript Catalogue of Drawings.*
[†] No. 107. *Ibid.*
[‡] No. 111. *Ibid.*

Fig. 1.

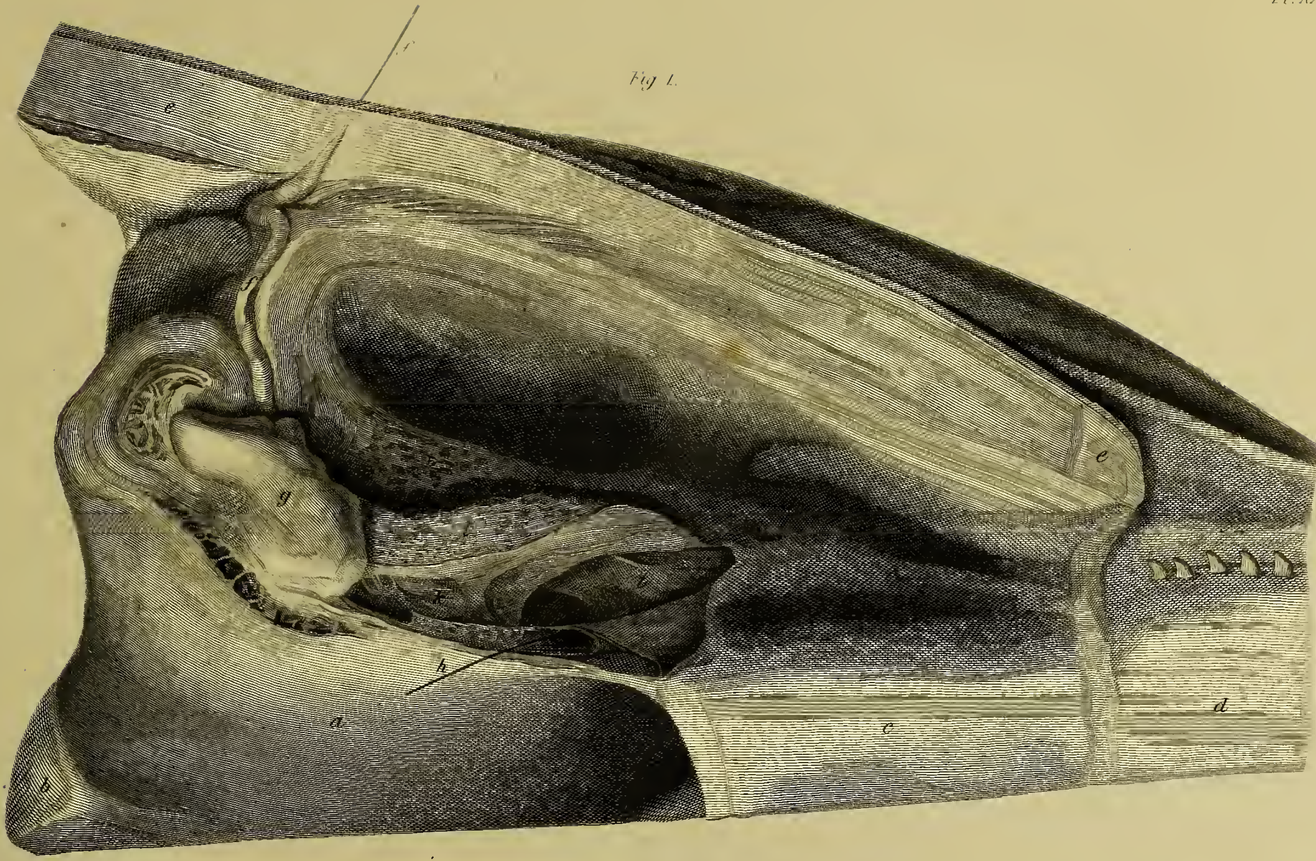
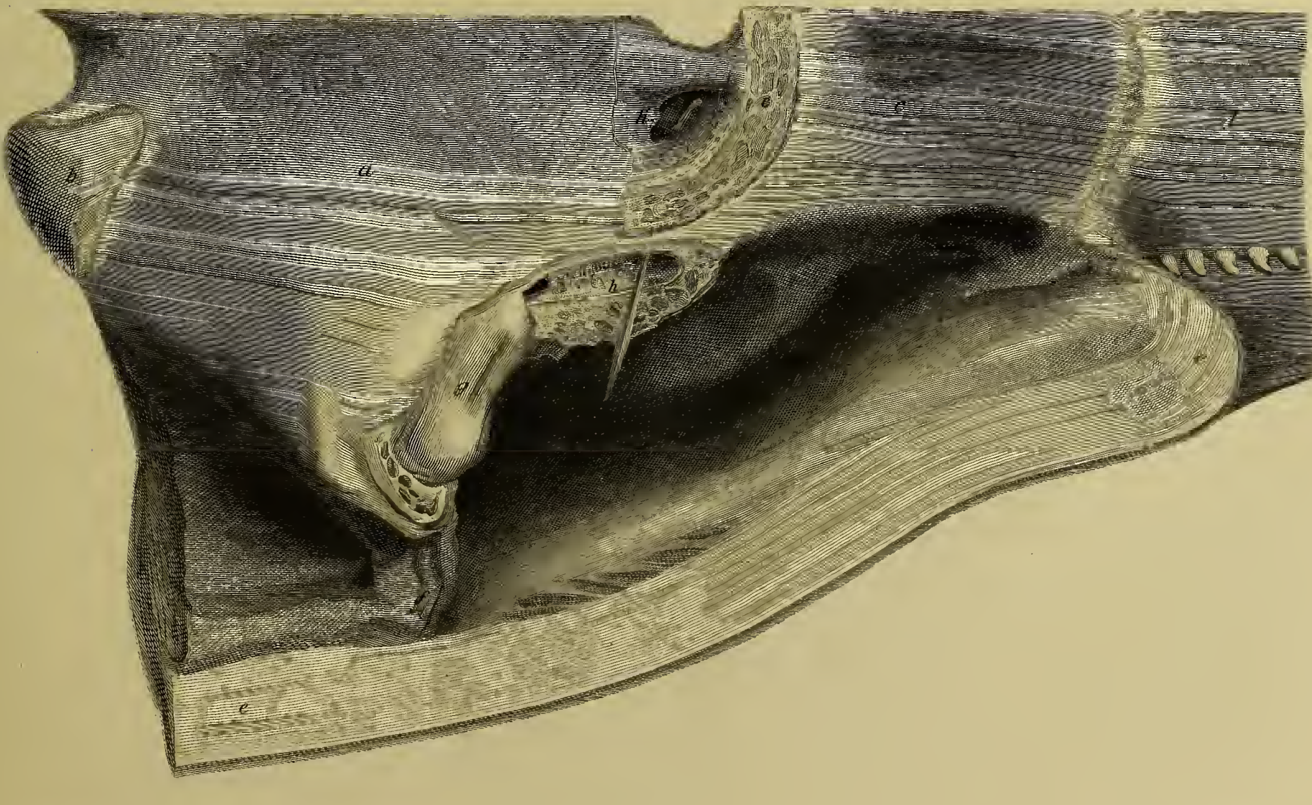


Fig. 2.



J. T. Wedgwood sc.

roof of the mouth with the basis of the skull is uppermost. A portion of the soft parts of the head are removed, to show those parts relating to the immediate organ of hearing."

Fig. 2.* is the opposite half of the same head, showing other parts of the organ of hearing. A portion of the bony palate is removed, to show the entrance of the Eustachian tube into the blowhole.

The same letters indicate the same parts in each figure.

a, The basis of the skull.

b, The occipital condyles.

c, The bony palate. (In fig. 2. the latter is placed on the cut surface occasioned by the removal of part of the bone in order to show the nasal opening of the Eustachian tube.)

d, The roof of the mouth.

e, e, Section of the skin and adipose membrane. (In fig. 1. it is cut down to the level of the meatus auditorius externus.)

f, The meatus auditorius externus. (In fig. 1. it is exposed through its whole length, and a bristle is passed into it.)

g, The dense bony tympanum *in situ.*

h, A bristle passed into the Eustachian tube. (In fig. 2. the termination in the blowhole is exposed, and a small probe passed through it, the extremity of which is seen at *h'*.

i, The mouth of a sinus passing from the Eustachian tube towards the lateral parts of the basis of the skull near to the exit of the optic nerve.

k, A continuation of these sinuses into the tympanum.

l, Cells in the bone, and connexion of the tympanum to the head.

PLATES XXXV. TO XLI.

Are illustrative of the comparative anatomy of the organ of Hearing, and, with the exception of Plate XXXVI., were presented to the College by Sir Anthony Carlisle, F.R.S., at whose expense they were engraved. They were originally designed for an 'Essay on Sound, and on the Organs of Hearing generally,' which formed part of the Course of Lectures delivered in the Theatre of the

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* No. 12 *Manuscript Catalogue of Drawings.*

Royal College of Surgeons, London, in the year 1818. Of this essay, hitherto unpublished, the following abstract was annexed by the author to the Plates presented by him.

"The Hunterian method of physiological induction, by studying the connexion between structure and function under the least complex conditions, appears to be the true method of reading the book of Nature; for a contemplation of the most simple constitution of parts appointed for single purposes is the surest guide to the comprehension of the complicated structures, which serve more offices than one, or which hold intimate relations with other organs or parts in a more highly organized individual. In all cases of hearing, the impressing cause or sound being a vibratory motion, its ultimate impression on the sentient parts must be that of touch; and perhaps the antennæ of insects are their only resources for distinguishing the sonorous attritions of their limbs; sounds which would not have been given unless for useful purposes, such as the night-telegraphs of love, or of some other wants.

"The great use and purpose of sounds to the animal existence, and of appointed organs to note their different impressions, appears to be for nightly intelligence, and for telling the motions of distant objects not within the range of vision; and they are severally adaptations for the security and welfare of locomotive creatures, and not given to vegetables and nonlocomotive animals.

"Even the antennæ of insects, allowing them to be feelers of sounds, are not wasted upon their larvæ or chrysalides, because the locomotions in the one state are very limited, and in the other none at all.

"Two different circumstances appear to belong to the production of sounds: the first is the peculiar vibrations which result from different degrees of density regulating the comparative frequency of vibrations among the particles of differently constituted substances; and this affords the characteristic *tone* as it happens in the metals, glass, wood, &c.

"The other modification of sounds results from the bulk, tension, or other condition of a vibratory body considered as a whole, and on this the given *note* depends; and as every musical instrument exhibits both the *tone* of its materials and the definite *note* artificially imposed by its construction, the union may be said to present two kinds of vibrations, the one of *tone*, the other of *note*. Certain concussions of the atmospheric air, and of water, as in thunder, and in the roaring of a stormy sea, appear to be limited by the masses of air or water struck together, and hence in neither instance is any definite *note* produced. But it further appears, that in the transmission of sounds through various media, the tone of *dense* bodies is not equally well conducted through substances of *less* density ; and hence some failure in the exactness of distant representations may occur, particularly when the quick vibrations constituting the tone of dense bodies have to pass through a substance possessing less capability of rapid sonorous vibration than the substance in which the given sound had originated.

"This view of the subject may tend to explain the purpose of constructing the organs of hearing, and their ultimate recipients for containing the auditory nerves, of very dense materials, as in the ossicles of the tympanum and the petrous portions of the auditory bones.

"These phænomena are also applicable to explain the uses of the dense bones placed in the membranous vestibulum of fishes, those being the appropriate repeaters of the collision among rocks and stones on the sea-shores, which inform certain wandering fishes of the nearness of dangerous breakers.

"True fishes have no converse with aërial creatures ; they constantly abide immersed in water, and that medium is the only conductor of sounds to them. The organs of hearing in fishes are therefore differently constructed from the organs of hearing in the aërial creatures ; and, although water is capable of conducting both tones and notes, the organs of voice not being required for the well-being of fishes, they are only provided with more simple organs of hearing, ordained to inform them of collisions among rocks and stones, or the rushing of water, or moving bodies in that element: and since the collisions of stones or of water, are only variable in their magnitude or intensity, fishes are provided with these dense ossicles to repeat the semblable acute tones of similarly dense substances, such as rocks, stones, gravel, &c. As to the rushing or collisions of water, those vibrations may be felt by the sense of touch throughout the whole surface of the skin ; and we may feel the gross vibrations of a drum by holding a scroll of stiff paper in the hand.

"This beautiful adaptation of the exact portion of sonorous intelligence bestowed on fishes by the construction of their organs of hearing, is, among endless other examples, a proof of the exact but yet sufficient providence or protection afforded to the inhabitants of water.

"There is an especial sac of calcareous pulp given to Skates and some other cartilaginous fishes in the place of the dense ossicles, apparently intended to respond to the movements of sand and muddy strata on which they are doomed to reside; and it is remarkable that the Sturgeon has its auditory ossicles consisting partly of hard substance and partly of calcareous pulp. In the Whale tribe aërial thunder issues from their lungs; and the booming of their voices is well adapted to convey intelligence of distances to each other when parted by ice-islands, while their organs of hearing, adapted by filling the tympanum with water, become hydrophonic organs, and tell the distant collision of stones, of rocks, and icebergs."—*Manuscript Essay on Sound by Sir A. Carlisle, F.R.S.*

PLATE XXXV.

Otolithes of the organ of Hearing of different Fishes.

The names of the species to which they belong are engraved on the plate above each specimen. Two views are given of each otolithe, showing its convex or outer, and concave or inner surface; magnified figures are added of those of the Herring, Gudgeon, and Dace. The otolithes are wholly calcareous, dissolving in acid with a brisk effervescence. They are not organized like true bone, but rather resemble shell, and in texture are analogous to the crystallized enamel of teeth. Though varying considerably in shape, this is always constant in the same species, of which it is characteristic. In figg. 7. and 8., (the otolithes of the Pike,) *o*, *r*, indicate the larger otolithe, which is contained in the vestibule of the labyrinth; *n*, *p*, *q*, *s*, the smaller otolithes taken from the sacculus.

PLATE XXXVI.

Stapides and Columellæ of the organ of Hearing in different animals.

a, The left* stapes of a Human ear, magnified two diameters, presenting the curved edge of the basis, and the more elevated and pointed arch.

b, The opposite side of the same stapes, showing its rounded arch.

c, Two figures, the uppermost being the articulating surface of the capitulum, and the one beneath showing the under surface of the basis, of the same stapes.

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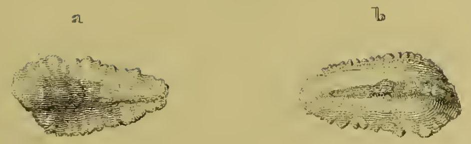
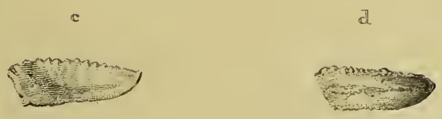
* The other Stapides are all from the right ears.

BONES from the EARS of FISHES.

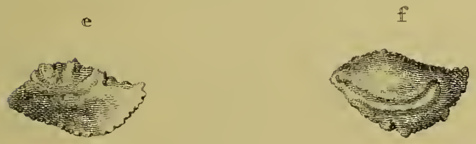
I. COD



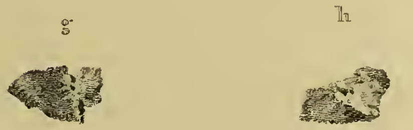
II. HADDOCK



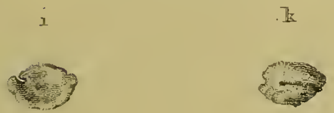
III. CORYPHENE



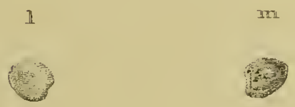
IV. STURGEON



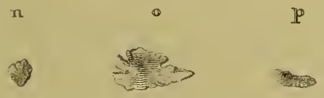
V. PLAICE



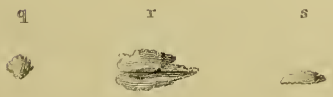
VI. SOLE



VII. PIKE



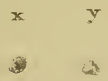
VIII. PIKE



IX. HERRING

X. GUDGEON

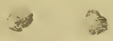
XI. DACE



IX. MAGNIFIED

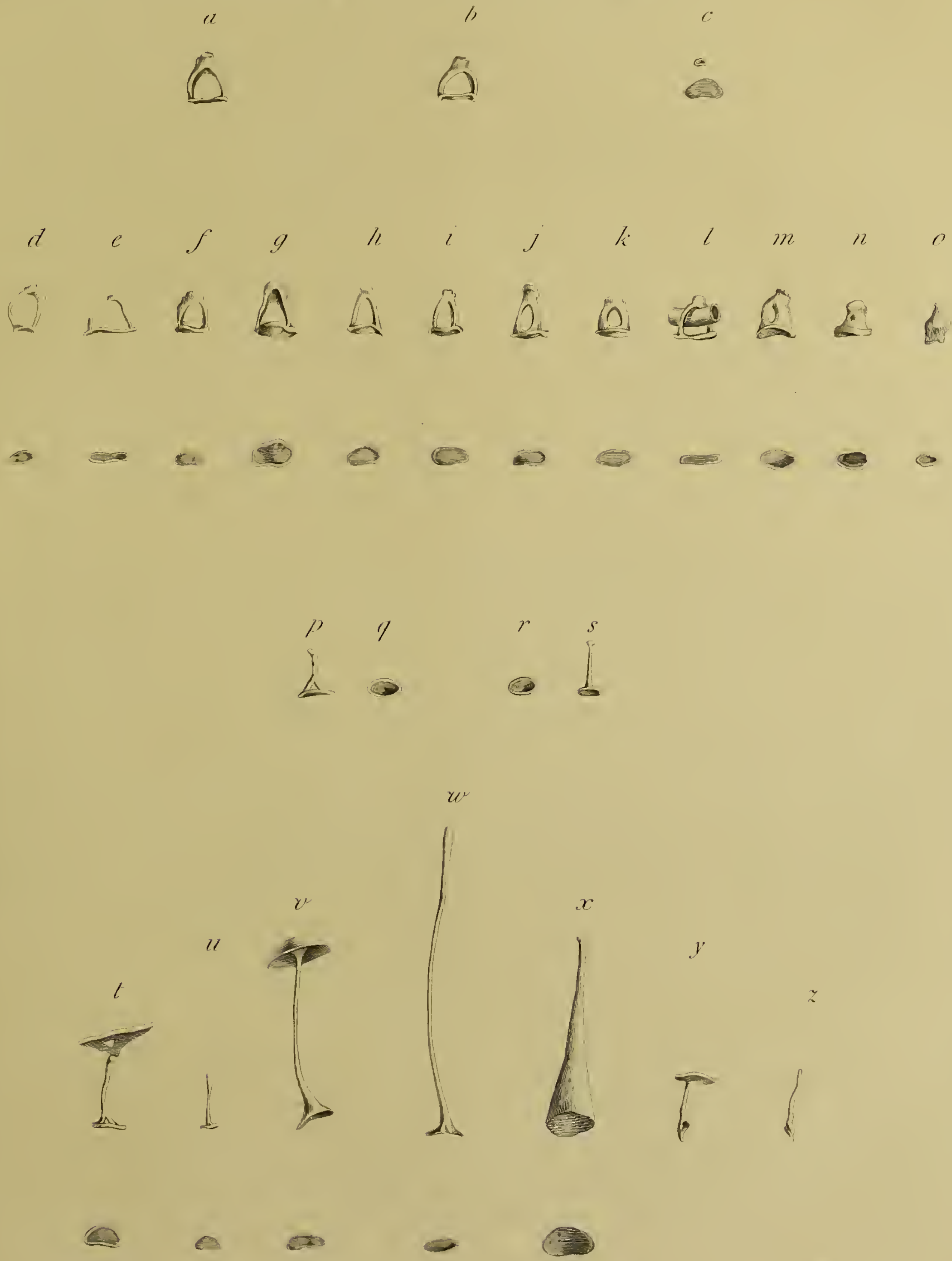
X. MAGNIFIED

XI. MAGNIFIED



Engraved by J. Greig

STAPEDES and COLUMELLÆ compared.



Basire sc.

d, Stapes of a Hedgehog magnified four diameters.
e, Stapes of a Mole, magnified six times.
f, Stapes of a Musk-ox, twice magnified.
g, Stapes of an Elephant, natural size.
h, Stapes of a Tiger, twice magnified.
i, Stapes of a Dog, three times magnified.
k, Stapes of a Pig, three times magnified.
l, Stapes of the Marmot, with its pessulus, magnified four times.
m, Stapes of the Seal, twice magnified.
n, Stapes of the Porpesse, twice magnified.
o, Stapes of the Walrus, natural size.
p, Stapes of the Kangaroo, four times magnified.
q, Under surface of its basis.
s, Columella of the *Ornithorhynchus paradoxus*, magnified four times.
r, Basis of the same columella.
t, Columella and cartilage of a Goose, twice magnified.
u, Columella of the Egyptian Ibis, taken from a mummy, three times magnified.
v, Columella of a Turtle (*Chelonia Mydas*), natural size, with its cartilage.
w, Columella of the Gangetic Crocodile, natural size.
x, Columella of a Turtle (*Sphargis coriacea*, MERREM), natural size.
y, Columella and cartilage of a Frog, twice magnified.
z, Columella of a Toad, twice magnified.

The third and last lines of objects in this plate exhibit the outlines and under surfaces of the bases of the stapides and columellæ immediately above. In some the surface is convex, in others concave, but neither the one nor the other is a constant attendant on any common affinity.

This Plate, engraved in illustration of a Paper by Sir A. Carlisle 'On the Physiology of the Stapes', printed in the *Philosophical Transactions* for 1805, p. 198, has been liberally granted by the Council of the Royal Society to the College of Surgeons for the use of the present volume of the Gallery Catalogue.

In the above Essay the author considers the ossicles of the organ of hearing in Man and in the Mammalia, as forming a series of conductors, whose office seems limited to the conveyance of sounds received through the medium of air; no parts corresponding to such bones being found in fishes. In two of the vertebrate classes, however, viz. Birds and Reptiles, there is only one ossicle of the tympanum, which is in the situation of the stapes.

The configuration of the stapes, or indeed of the other ossicles, is not governed, according to the author, by the form, habits, or voice of the animal, except in those mammals which inhabit the waters, such as the Seal, Walrus, and the Whale tribe: in these the stapes is more massive; but in the Otter, which only dives occasionally, the stapes does not differ from that of the Fox. In the Tiger, the Dog, and other Feræ, the crura are straight, and meet in an acute angle; but the same figure occurs in the Horse, in the Beaver, in the Goat, and in many other herbivorous quadrupeds. In the Cetacea the muscle of the stapes pulls the capitulum at such an angle, as very much to depress its subjacent end into the fenestra vestibuli; and the joint appears capable of considerable motion. In the Walrus this ossicle is entirely solid; in the Seal and in the Cetacea, the bone has only a perforation instead of the crural arch.

" One of the most interesting discoveries related in this paper, is a very remarkable singularity in the stapes of the Marmot, and in that of the Guinea-pig. In those animals the bone is formed of slender crura, constituting a rounded arch; through this arch an osseous bolt passes, so as to rivet it to its situation. This bolt, to which the name of 'pessulus' is given, is placed near the top of the arch, so that by the action of the stapidius muscle, the upper part of the straight crus is brought into contact with the pessulus.

" The use of this mechanism is not obvious, there being nothing in these animals, excepting their shrill whistle, peculiarly different from others which are destitute of such mechanism. In the Kangaroo the stapes is like the corresponding ossicle in Birds, called Columella. In the Ornithorhynchus and Echidna this resemblance to the columella is still more striking, and forms an additional point of similarity between these singular mammalia and the oviparous classes, as Birds and Reptiles. These columellæ are articulated to a small bone, which performs the office of the manubrium of the malleus; whereas, in Birds, the capitulum of the columella is slightly expanded, and is joined to a triangular plate of cartilage attached to the membrana tympani. In some Birds a small foramen occurs in the middle of this plate.

“ Reptiles are provided with columellæ similar to those of birds ; but the cartilage is united to the under surface of the true skin without any apparent application of muscles to alter its tension.

“ From the preceding circumstances the author is led, he says, to the following conclusions : ‘ In Man, and in most of the Mammalia, the figure of the stapes is an accommodation to that degree of lightness which seems a requisite condition ; and that bone is especially designed to press on the fluid contained in the labyrinth ; the ultimate effect of which pressure is an increase of the tension of the membrane closing the fenestra cochleæ.

“ There does not, in the author’s opinion, appear to exist any motion between the ossicula auditûs that bears any relation to the peculiar vibration of sounds. He rather conceives that the different motions of these bones only affect the membrana tympani, so as to lessen the intensity of violent impulses. Sounds of less impetus, not requiring such modulation, are transmitted by the vibrations of the integrant parts of these bones, unaccompanied by muscular action.

“ This reasoning is suggested by the columella in Aves and Amphibia ; for since many birds accurately imitate a variety of sounds, it may be inferred that they hear as acutely and as distinctly as mankind.

“ The muscles of the ossicula auditûs appear to be of the involuntary kind ; their peculiar stimulus is sound, and the chorda tympani is a gangliated nerve. If the above supposition is true, the muscles may be considered as all acting together ; especially as it is well known that some persons who hear imperfectly are more sensible to sounds when in a noisy place, as if the muscles were then excited to action.

“ It cannot, the author thinks, be allowed, that the pressure of the watery fluid in the labyrinth is necessary to produce the sensation of hearing, since birds hear without any such mechanism : such pressure, however, would give increased tension to the fenestra cochleæ ; and as the membrane of that fenestra is exposed to the air contained within the cavity of the tympanum, it appears adapted to receive such sounds as pass through the membrana tympani, without exciting consonant motions in the ossicula auditûs.

“ In order to investigate the truth of the above opinions, the author had water, at the temperature of his body, dropt from a small phial into the meatus externus, the tragus being previously pulled towards the cheek. The first drop produced a sensation like the report of a distant cannon ; and the same effect succeeded each drop until the cavity was filled.

“ In this experiment the vibrations of the membrana tympani must, he says, have been impaired, if not destroyed ; yet the motions of the membrane produced by each drop of water affected the air contained in the tympanum, sufficiently to produce a sensible impression.

“ That something like this occurs in many kinds of sounds is more than probable ; and as the cochlea consists of two hollow half-cones, winding spirally, and uniting at their apices, it follows that the sounds affecting either of the cones must pass from the wide to the narrow end ; and the tension of the parts in either case will necessarily aid the impression.”

PLATE XXXVII.

Ossicles of the Human Tympanum.

a, The malleus. *b,* The incus. *c,* The lenticulare. *d,* The stapes.

e, f, g, h, Different views of the same bones.

In the magnified figures, which show the relative positions of the ossicles,

a, Is the manubrium, or handle of the malleus.

b, The processus gracilis.

c, The enlarged body.

d, The short crus or leg of the incus.

e, The long crus of the incus.

f, The lenticulare.

g, The capitulum, or head of the stapes.

h, The collum.

i, The slender crus.

k, The stronger and more curved crus.

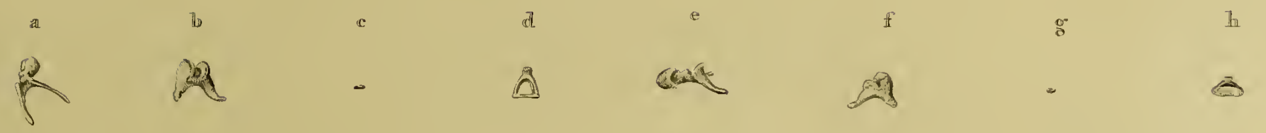
l, The base of the stapes.

m, The insertion of the tensor tympani.

n, The insertion of the stapidius.

The following description of the parts displayed in this Plate is taken from Sir Anthony Carlisle's Paper ‘On the Physiology of the Stapes’, in the *Philosophical Transactions*, 1805, p. 199.

OSSICLES of the HUMAN TYMPANUM



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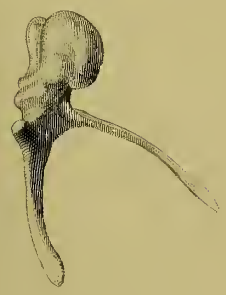
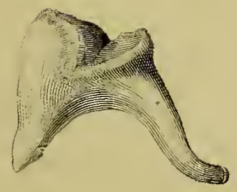
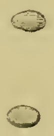
MALLEUS



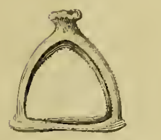
INCUS



LENTICULARE



STAPES



RELATIVE POSITIONS

I

II

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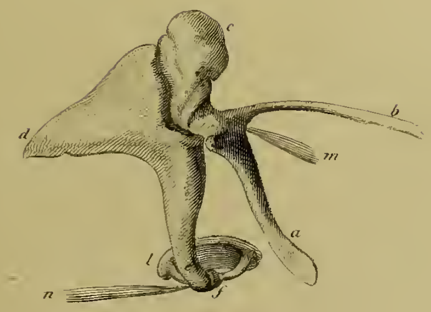
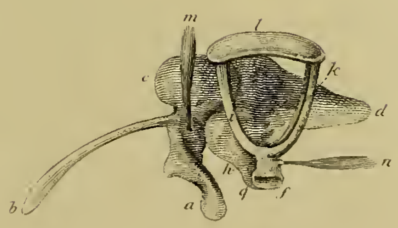




Engraved by J. [illegible]

" The ossicula auditûs are formed of bone, close in texture, and brittle in the growing state ; composed of a vascular pulp, the ossification of which is completed soon after birth ; and, like the teeth, they cease to grow after that process is finished. The malleus and incus are hollow, and possess an internal periosteum ; and the whole series is covered by a reticular membrane, which has no red blood-vessels in the adult. It has been asserted by many authors that fat, or marrow, is contained in these bones, but I am induced to attribute their occasional greasy appearance to transudation from the neighbouring parts during the stage of putrefactive maceration, seeing that all such bones when taken from recent subjects are free from the marks of fat. Although density seems to be a requisite condition, yet it is convenient that the bones shold not be massive, as their figures and relative adaptations evidently show.

" The malleus is united to the membrana tympani throughout half its long diameter, by a process called manubrium ; its detached end forms a rounded enlargement, which is articulated by a sort of hinge joint to the body of the incus. Three muscles are fixed to the malleus, the most powerful of which draws the manubrium and the membrana tympani perpendicularly inward ; the next in strength is inserted upon a slender stem of bone, which forms a right angle with the manubrium, and on the plane of the membrana tympani. The smallest muscle is fixed to the processus major, pulling the malleus backward, and pressing its head against the joint of the incus. These muscles are all restricted in their actions to the changes produceable on the membrana tympani, because the strong connexions of the joints between the malleus and the incus, and the incus and stapes, admit of little motion ; indeed the former joint is deficient in many animals. The incus has no muscles, and forms only a passive intervention between the malleus and stapes, which last bone has a peculiar muscle appropriated to itself. Hence, it appears, that the first series of ossicula auditûs has a different office from the stapes, as will be subsequently explained.

" The bone to be now particularly considered has been called stapes, staffa, stapha, or stapeda, from its resemblance to the stirrup of a saddle. It was first observed about the middle of the sixteenth century; and Philip ab Ingrassias, Realdus Columbus, and Bartholomæus Eustachius, have contested the honour of its discovery.

" The human stapes is $\frac{6}{40}$ of an inch in height, and $\frac{5}{40}$ in width at its basis: it weighs, when dried, $\frac{1}{32}$ of a grain.

" It is divided into the following parts, viz.

" The capitulum, or articulating head, which joins the os lenticulare.

" The collum, which unites the capitulum to the two crura.

" And the basis on which the expanded crura rest and terminate.

" The capitulum stapidis has a shallow concave surface to receive the os lenticulare, or epiphysis connected to the long leg of the incus. (Vide Plate IV. letter *c.*) Around this joint a strong membrane is applied in the manner of a capsular ligament. The capitulum is seldom placed exactly on the top of the Gothic arch formed by the crura, and the crus immediately under the stapidius muscle is always the thickest, and most curved. (Vide letter *k.*)

" The collum is hollow, being only a thin shell of bone; on its side is a small tubercle, to which the tendon of the stapidius muscle is affixed. See letters *a* and *b.*

" The crura are curved, and their interior surfaces are grooved, leaving only a thin osseous plate.

" The basis is exactly adapted to the fenestra ovalis, more properly called fenestra vestibuli by modern anatomists, and the two ends project beyond the crura. The upper surface is generally concave, the under surface slightly convex; and here a rising border marks the insertion of the membrane which connects it to the edges of the fenestra vestibuli.

" The outline of the basis somewhat resembles a long semi-ellipsis, one side being nearly straight, and the other convex. This figure appears adapted to the expansion of the basis, without increasing the bulk of the bone, whilst it gives leverage to the muscle.

" When the stapes rests on its basis, with the straight side next to the observer, if the more curved leg be toward the left, then it is the stapes of the right ear; but if on the right, then it is the left stapes. The arch above the straight side of the basis is more rounded than that above the curved side; the latter being an intersection of two curves like the Gothic arch. I have never seen that expansion of membrane across this arch described by Du Verney; and from the great number of ears which I have attentively examined, am induced to think that a pellicle of mucilaginous fluid, which often covers the recent bone, has been mistaken for a membrane.

" The stapes stands perpendicular to the plane of the membrana tympani; a plane drawn through the crura, parallel to the length of the basis, equally bisects the cavity of the tympanum.

" The stapidius muscle arises within a special cavity in the petrous portion of the temporal bone; it is a short, thick mass of red fibres, covered by fascia, and sends forth a round tendon through a small osseous aperture at the point of the pyramidal eminence, which unites to the collum stapedis in an angle of fifty degrees, toward a line drawn perpendicular to the plane of the basis, and obliquely across its convex side, in an angle of five degrees from the bearing of its straight side. The action of the stapidius muscle is to draw the capitulum downward, and toward the curved side of the basis. This oblique motion depresses the end of the basis under the curved crus, whilst it rotates the incus upon its short leg, and presses its articulation with the malleus into closer contact: but the stapes is not withdrawn from under the long leg of the incus, being prevented by the strong connecting ligaments.

" The smaller angle of the tendon crossing the parallel of the crura over the convex side of the basis, necessarily depresses that edge, the straight side acting as a hinge. The externus muscle of the malleus rotates the incus back again, and restores it to its passive perpendicular situation, becoming on such occasions the antagonist of the stapidius. It is worthy of remark, that all the muscles of the ossicula auditûs act nearly at right angles, or in straight lines, contrary to the ordinary course of muscular application, by which their forces are comparatively augmented.

" The varieties in the human stapes are few: they appear in the relative curvature of the crura, and in the degree of slenderness or symmetry of its general form.

" The fenestra vestibuli admits the basis of the stapes to pass into the vestibulum when the connecting membrane is destroyed, there being no other obstacle to its descent."—*Philosophical Transactions,* 1805, p. 199.

PLATE XXXVIII.

The passages leading to the tympanum in the Human subject.

Fig. 1. Section of the Human head, showing the auricle, or part of the external meatus, and the Eustachian tube *in situ.*

a, The cut edge of the tragus, which has been removed to show the oblique passage leading to the meatus auditorius externus.

b, The eminentia articularis of the glenoid cavity.

c, The expanded or cartilaginous portion of the Eustachian tube.

d, The occipital condyle.

e, The styloid process.

Fig. 2. A further dissection of the same parts.

g, The inner surface of the meatus auditorius externus, showing the pores of the ceruminous follicles.

h, The membrana tympani, or drum of the ear; its transparent texture permits the manubrium of the malleus to be seen through it.

i, The bony part of the Eustachian tube.

PLATE XXXIX.

A section of the Human head, showing the relations of the opening of the Eustachian tube to the septum narium, soft palate, and surrounding parts.

a, The tumid lip or valve-like termination of the Eustachian tube formed by thickened and glandular mucous membrane which surrounds the cartilage at that part.

b, Cut surface of the uvula and soft palate.

c, The tonsil.

d, The mucous membrane at the lower margin of the Eustachian tube.

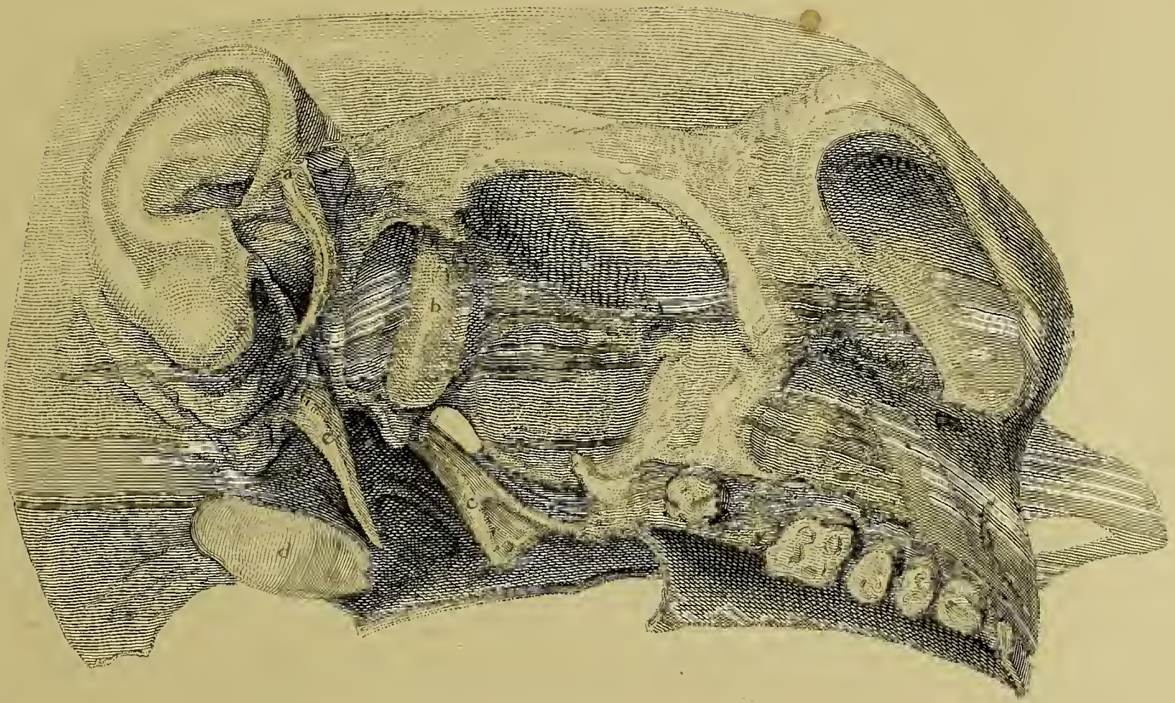
PLATE XL.

Two views of the termination of the Eustachian tube, showing its relations to the muscles of the soft palate.

a, The superior lip or valvular part of the termination of the Eustachian tube.

PASSAGES to the TYMPANUM.

I



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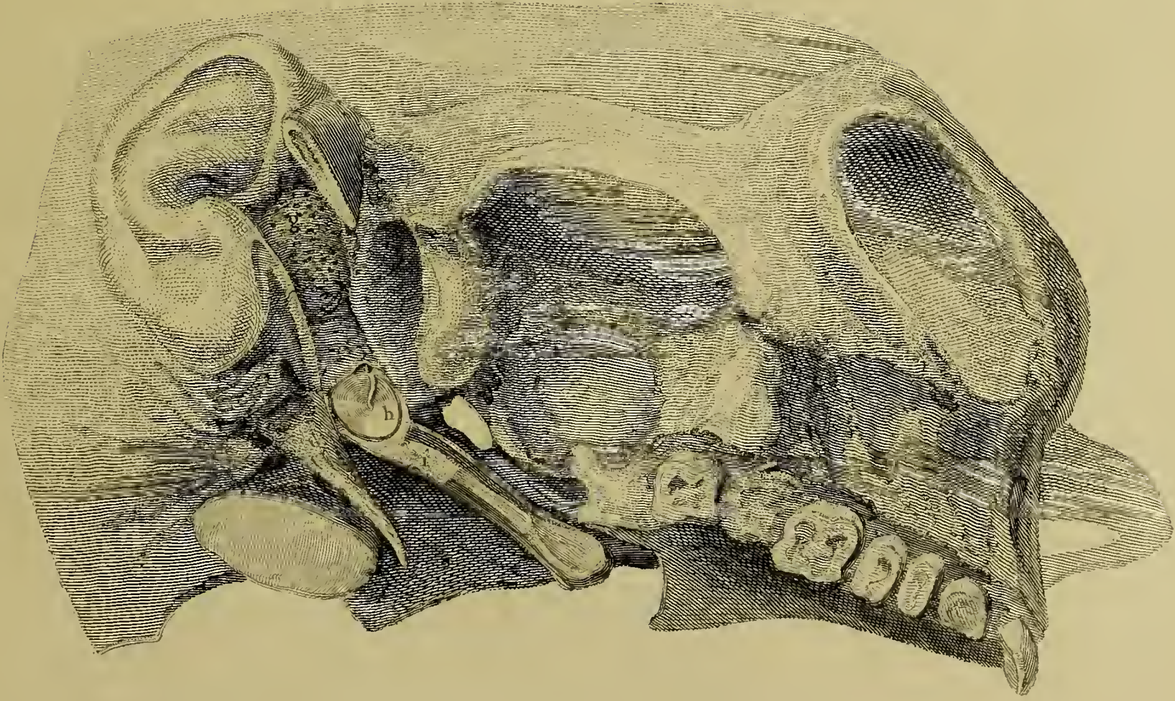
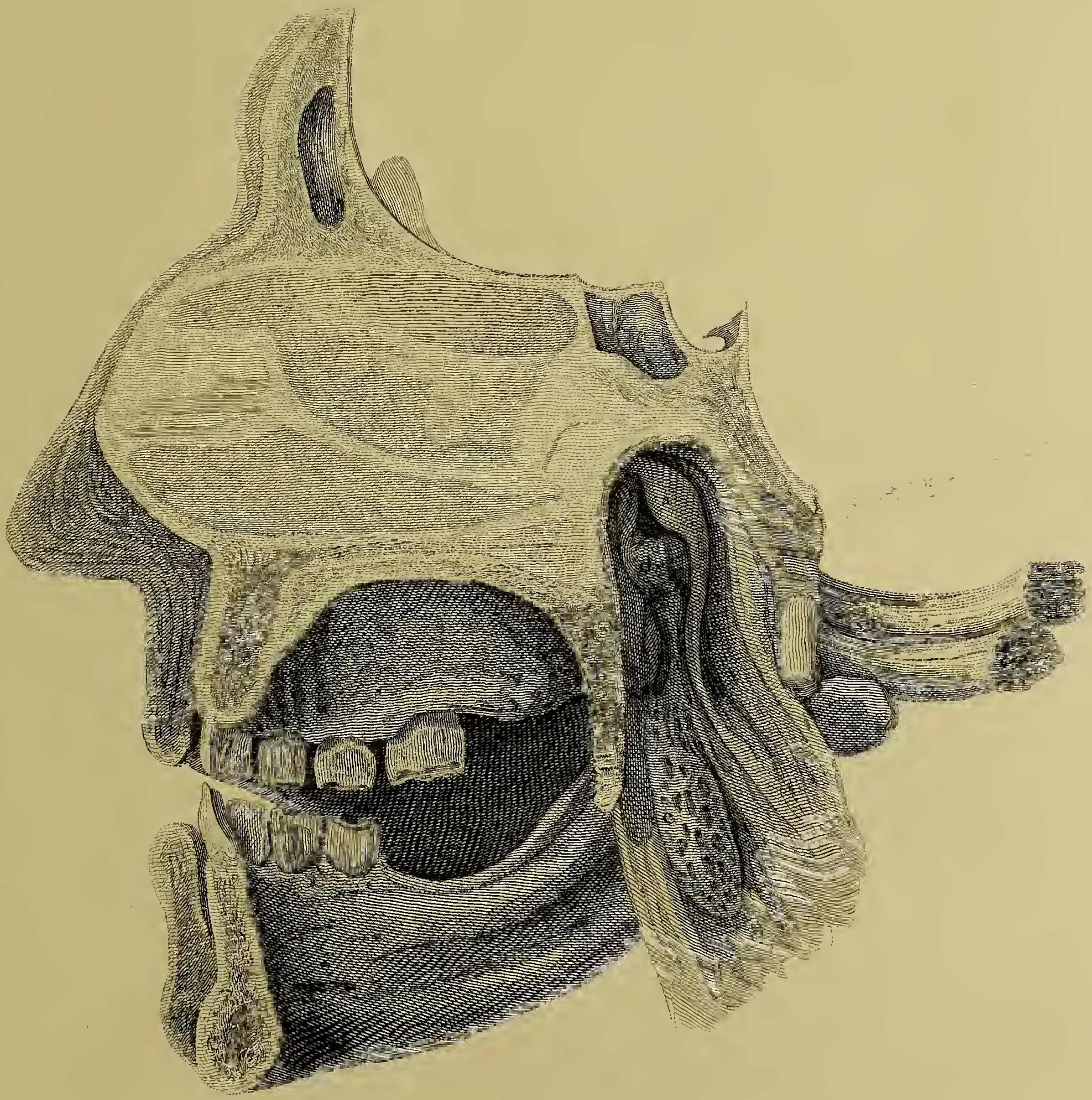


Pl. XXXIX.

EUSTACHIAN MEATUS.



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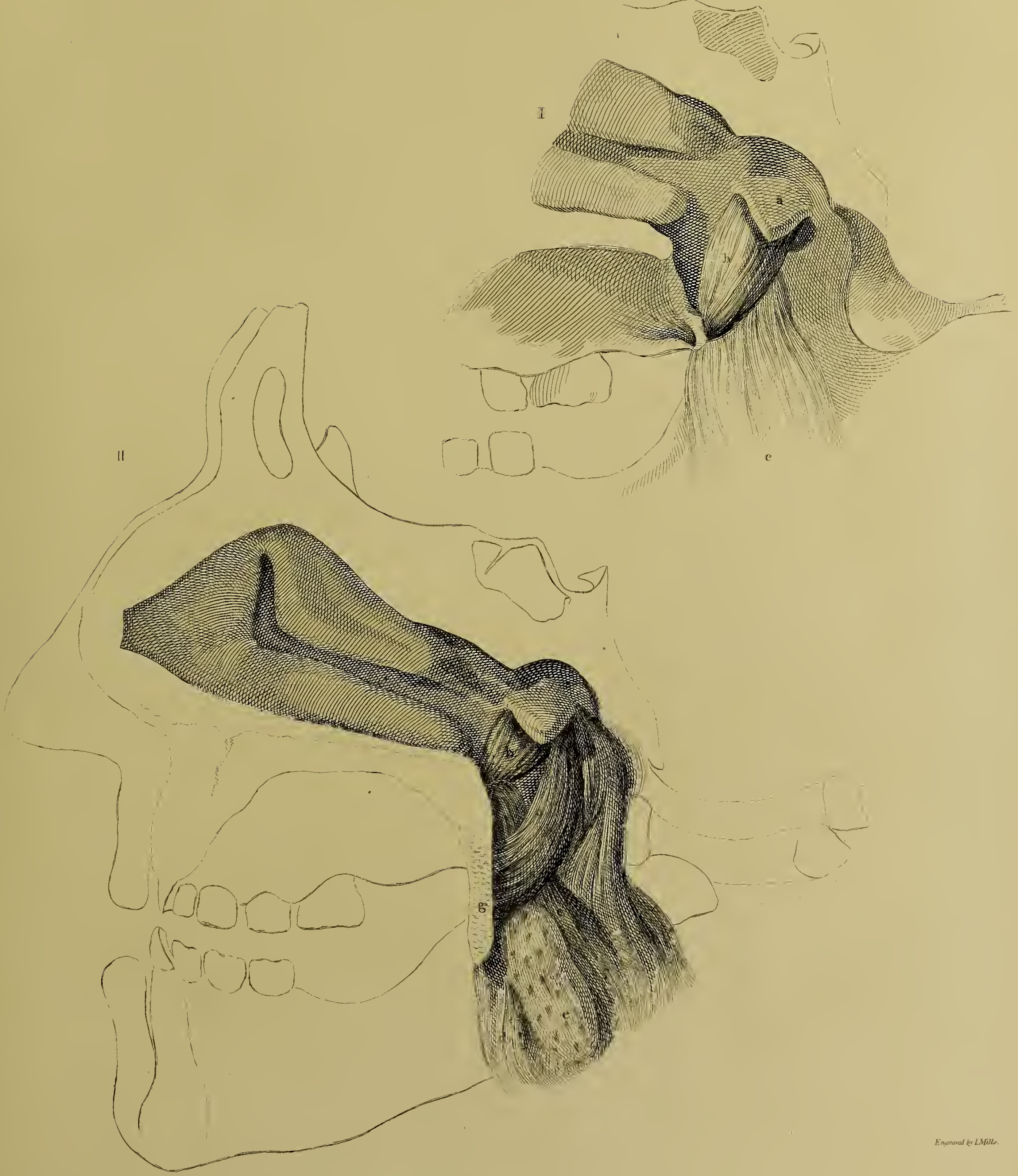
EUSTACHIAN MEATUS and its MUSCLES.

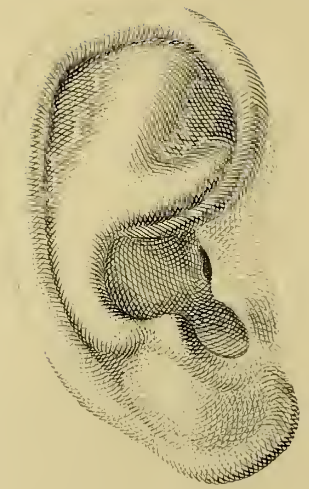


Engraved by I. Mills.

HUMAN EXTERNAL EAR.

I

AURICLE



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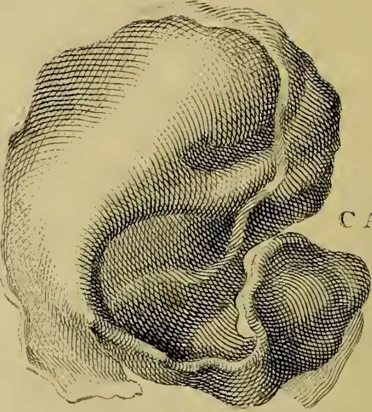
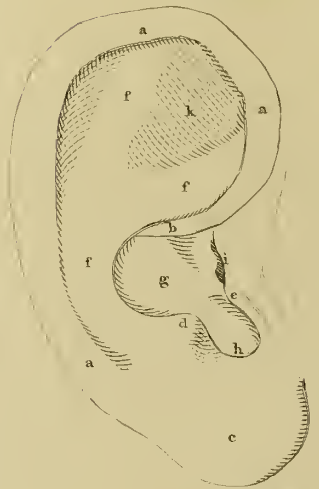


CARTILAGE

OUTLINES

I



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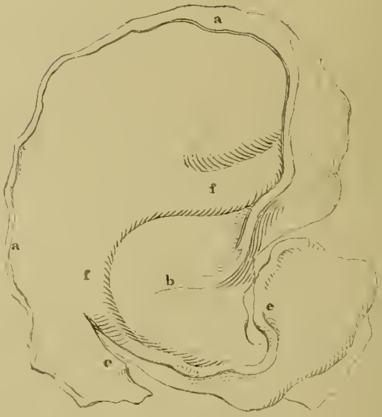
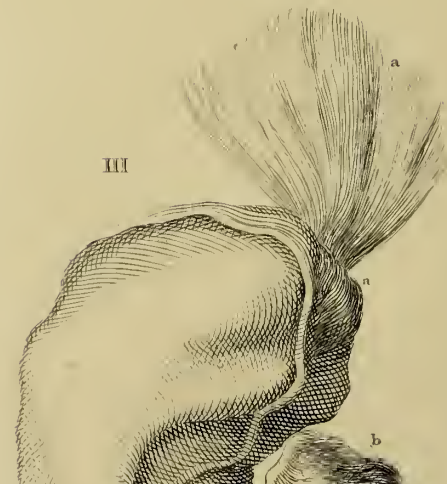


MUSCLES of the AURICLE

III



IV

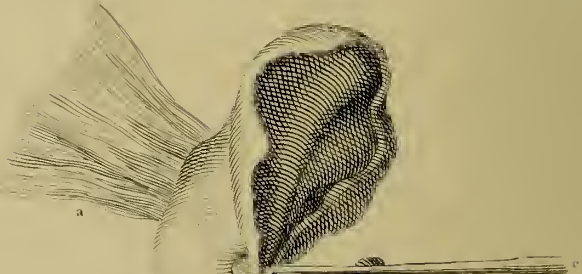


Fig. 1.

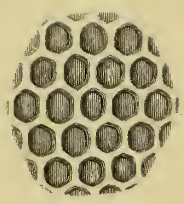


Fig. 2.

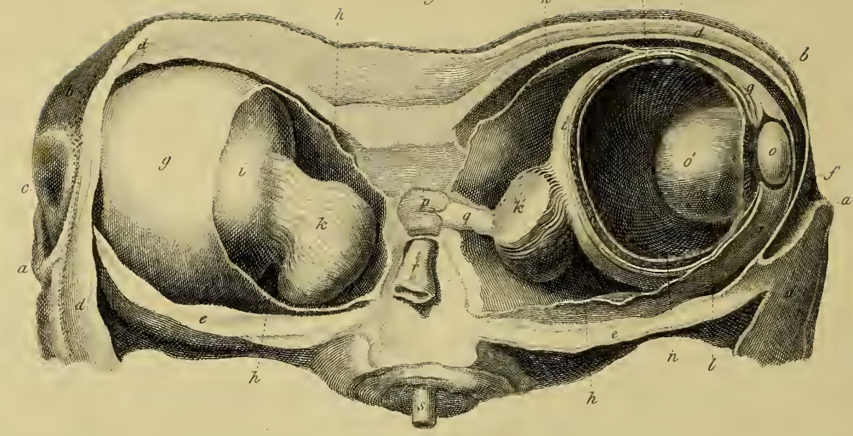


Fig. 3.

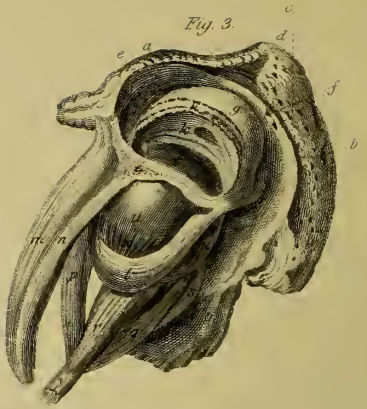


Fig. 4.

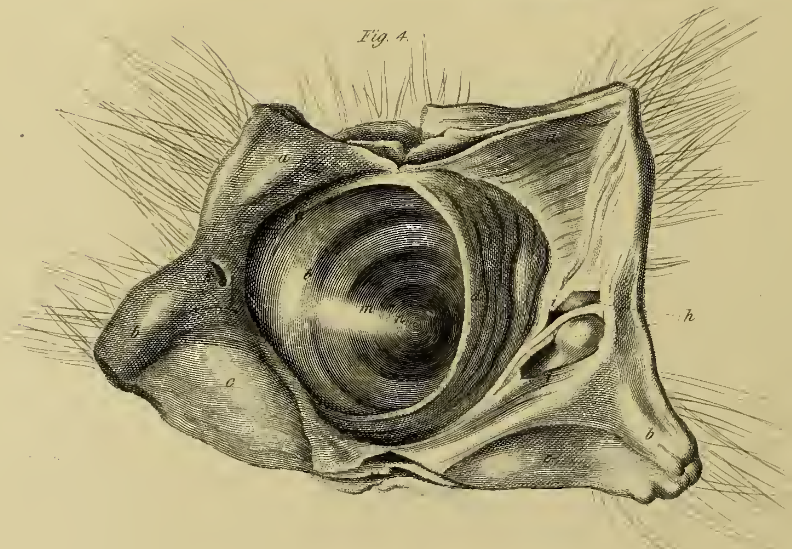


Fig. 5.

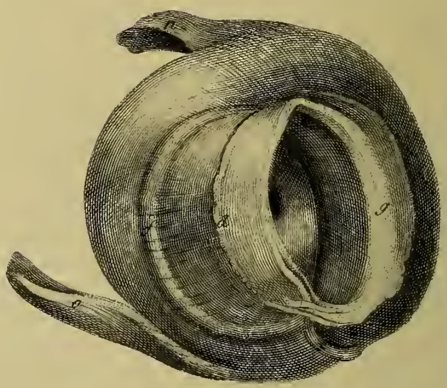


Fig. 6.

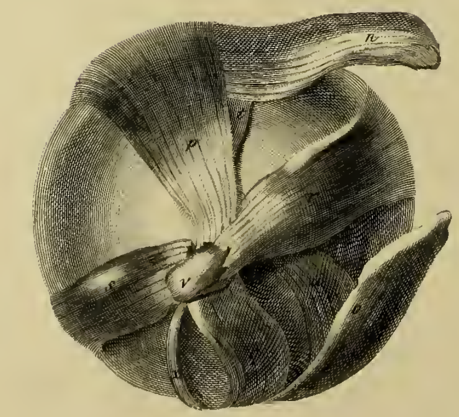
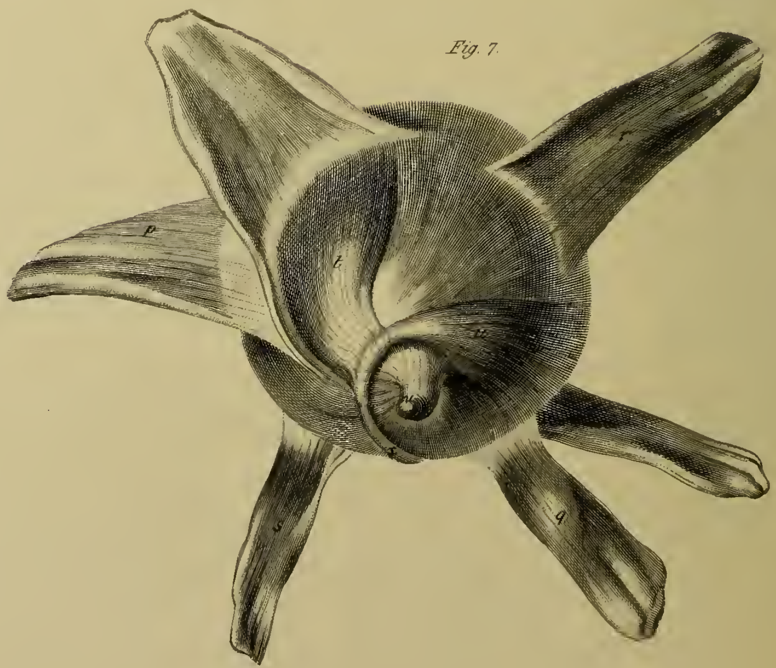


Fig. 7.



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b, The circumflexus palati muscle.
c, (fig. 2.) The tensor palati.
d, The palato-glossus.
e, The tonsil.
f, The palato-pharyngeus.
g, The cut surface of the uvula.

PLATE XLI.

Fig. 1. The pinna or auricle of the external ear of the Human subject (European).
a, *a*, *a*. *b*, The helix.
c, The lobulus.
d, The antitragus.
e, The tragus.
f, *f*, *f*, The anthelix.
g, The concha.
h, The sinus.
i, The orifice of the meatus externus.
k, The depression of the anthelix or fossa navicularis.
Fig. 2. The cartilage of the auricle: the letters on the outline indicate the same parts as the preceding.
Fig. 3. The cartilage of the auricle, with *a*, *a*, The attollens aurem. *b*, The tragicus. *c*, The antitragicus.
Fig. 4. The cartilage of the ear drawn aside to show *a*, *a*, The retrahentes auriculam, *b*, The tragicus.

PLATE XLII.

Fig. 1.* Part of the cornea of a Grasshopper, greatly magnified, showing it to be composed of a number of hexagonal segments, each of which admits light to a pyramidal cavity provided with a distinct lens, choroid, pigment, and retina; the whole forming the compound eye peculiar to Insects.

* No. 115. *Manuscript Catalogue of Drawings*.

" *Fig.* 2.* Exhibits the different parts of the eye in the Cuttle-fish, and also such parts as belong to it. It is a view from behind, the head being separated from the body.

" The eye of the Cuttle-fish is not similar in structure to any eye known. What may be called the true globe of the eye has no cornea, being perforate like the iris. The whole is inclosed in a circumscribed cavity, composed partly of cartilage, which may be called the internal orbit, but principally of the external skin, the outer part of which is transparent and makes the cornea. From the globe of the eye all round near to its middle or greater circumference passes back a thin membrane as it were, lining the posterior part of the orbit, which incloses the optic nerve and a pulpy substance which surrounds the nerve. The optic nerve is also very singular. When it has entered the orbit it swells out into a large round ball, from the circumference of which small filaments of nerves arise, which cover their origin, and pass to the ball of the eye where they enter.

" Of the parts common to both eyes.

" *a,* The external skin which terminates before the eye in a loose edge, making something similar to an under eyelid.

" *b,* The skin above the eye, terminating below in the cornea, *c*.

" *d, d,* The cut edge of the skin of the head all round, making the upper and outer parts of the two orbits.

" *e, e,* The cut edges of the lower part of the orbit.

" *f,* The continuation of *e* on the right side, becoming thin and forming the cornea, which is continued into *d* above.

" *Of the left eye.*

" *g,* The globe of the eye covered by the exterior layer of the sclerotica.

" *h, h,* The cut edge of this outer layer of the sclerotic, which forms the capsule of the optic nerve.

" *i,* The posterior part of the globe of the eye covered with a thin layer of the sclerotic, which completes the capsule of the optic ganglion anteriorly.

" *k,* The ganglion or bulbous part of the optic nerve.

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* No. 114. *Manuscript Catalogue of Drawings.*

" *Of the right eye.*

" A section is removed to show the deeper-seated parts and the optic nerves. The layer of the sclerotic *g* is seen to be perforated anteriorly.

" *k′*, *k′*, The bulbous part of the optic nerve, exposed by the removal of the superficial filaments which go to form the retina.

" *l*, Internal layer of sclerotica.

" *m*, That part of the choroid coat which may be called 'Iris.' (Its free margin is implanted in a circular groove of the lens.)

" *n*, 'The cut edge of the choroid coat.' (This is the expansion of the optic ganglion, or retina, covered anteriorly or internally with a layer of black pigment.)

" *o*, The anterior segment of the crystalline lens seen through the opening of the choroid and sclerotic coats.

" *o′*, The posterior and larger segment of the same within the cavity of the eye.

" *p*, Part of the brain.

" *q*, The optic nerve where it comes out of the brain.

" *r*, The œsophagus.

" *s*, The aorta."

" *Fig.* 3.* An external view of the eye, eyelids, muscles, &c. of a Crocodile.

" *a*, The external surface of the upper eyelid.

" *b*, The external surface of the under eyelid.

" *c*, Points to the edge of both eyelids.

" *d*, The inner angle or canthus of both eyelids.

" *e*, *e*, The internal surface of the eyelids covered by the tunica conjunctiva.

" *e′*, A continuation of the tunica conjunctiva round the cornea.

" *f*, Points to the two puncta lachrymalia on the inside of the under eyelid.

" *g*, The external surface of the third eyelid, or membrana nictitans.

" *h*, The loose or free edge of the same.

" *k*, The opening of the duct of the lachrymal gland, (glandula Harderiana,) 'upon the inner surface of the nictitating membrane ; this surface has been raised from the cornea, to which it naturally lies contiguous.

" *l*, The muscle which expands the membrana nictitans and draws it over the ball of the eye.' (This is the only muscle which is subservient to the movements of the nictitating membrane; it is analogous to the pyramidalis of Birds. (See *u*, figg. 6, 7.). The quadratus muscles and its sheath being wanting in Reptiles.)

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* No. 116. *Manuscript Catalogue of Drawings.*

" *m*, The levator muscle of the upper eyelid.
" *n*, A portion of the above muscle lost in the tunica conjunctiva.
" *o*, The depressor muscle of the under eyelid.
" *p*, The rectus superior, or attollens oculi.
" *q*, The rectus inferior, or deprimens oculi.
" *r*, The rectus externus, or abducens oculi.
" *s*, The obliquus inferior; only a small portion of it is here seen.
" *t*, The cornea.
" *u*, *u*, The globe of the eye, behind the cornea.
" *v*, The optic nerve.
" *x*, Insertion of the choanoid muscle, which consists of four distinct portions surrounding the optic nerve.
" *Figg*. 4. to 7.* Muscles of the eye and eyelids of an Ostrich (*Struthio Camelus*, LINN.).

" *Of the Eyes of Birds.*

" The eyes of birds have several peculiarities which are not to be found in the eyes of every animal. First, the principal motion in the eyelids is in the lower, contrary to that in most other animals. They have a thin broad cartilage between the two coats of the under eyelid, which prevents its being thrown into folds. Besides the eyelids, as a covering for the eye, they have a thin strong membrane placed upon the inside of the eyelids, or between the eyelids and cornea, whose direction and motion are at right angles with the eyelids; it is sufficiently broad to cover the whole anterior exposed surface, or all that surface which can and is occasionally covered by the eyelids. As this is to be looked upon as a supernumerary eyelid, it must have muscles, which are vastly well adapted for giving motion to this part.

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* No. 117. *Manuscript Catalogue of Drawings.*

"The duct of the principal lachrymal gland opens at the inner canthus, contrary to that of most other animals, which open on the outer and upper side; but the same purpose is answered in both.

"Within the eye there is a process arising from the choroid coat which projects inwards, making a dent of its own shape in the vitreous humour; all of which will be made clear in the Drawings."

"*Fig.* 4. This drawing is of the eyelids and eye. Both eyelids are slit through in their middle between the two angles, and are inverted, one half turned outwards, the other inwards, to expose their insides. It shows the puncta lachrymalia, the orifice of the external gland, the cartilage of the under eyelid, and the anterior part of the globe of the eye.

"*a*, The upper eyelid slit vertically.

"*b*, The under eyelid similarly divided.

"*c*, The two halves of the cartilage of the under eyelid.

"*d*, The vertical or third eyelid, or membrana nictitans, thrown into folds. (The letter is placed on the anterior part, which is covered by a reflection of the tunica conjunctiva.)

"*h*, The two little eminences answering to the carunculæ (lachrymales) which are within the opening of the punctæ, near the internal canthus.

"*i*, The two lachrymal passages, or rather the sac itself.

"*k*, The opening of the external, [or the true lachrymal] gland.

"*l*, The globe of the eye.

"*m*, The iris; *v*, the pupil, seen through the transparent cornea.

"*Fig.* 5. Is the fore part of the left eye, showing the membrana nictitans partly drawn over the anterior surface of the globe.

"*d*, The membrana nictitans, the free surface before, or to the right side of the line on which the letter is placed, is covered by a reflection of the tunica conjunctiva, the surface of the membrane behind the letter is not.

"*f*, Its attachment to the globe of the eye.

"*g*, Part of the tunica conjunctiva at the external canthus.

"*x*, The tendon of the musculus nictitans, (pyramidalis).

"*n*, The superior oblique.

"*o*, The inferior oblique.

" *Fig.* 6. Is a proterior view of the same eye, which shows the muscles nearly in their true situation on the eye.

" *n*, The superior oblique muscle.

" *o*, The inferior oblique muscle.

" *p*, The rectus superior, or elevator.

" *q*, The rectus inferior, or depressor.

" *r*, The rectus internus, or adductor.

" *s*, The rectus externus, or abductor.

" *t*, A portion of the trochlearis muscle of the membrana nictitans (musculus quadratus).

" *u*, The fleshy part of the circumflexus muscle of the membrana nictitans, or (pyramidalis).

" *x*, The tendon of the same.

" *v*, The optic nerve.

" *Fig.* 7. Is principally intended to show the last-mentioned muscles of the eye, viz. those of the membrana nictitans (*t*, *u*, *v*). The two obliqui, *n*, *o*, and the four recti muscles, *p*, *q*, *r*, *s*, are separated from their origins and turned out, which shows their insertion into the tunica sclerotica of the eye. The trochlearis, or (quadratus) *t*, and the circumflexus (pyramidalis), *u*, *v*, are so placed with respect to each other as to gain a double extent of effect with a given length of fibre."

Manuscript Catalogue of Drawings.